A HANDBOOK

OF

DENTAL PATHOLOGY.

BLODGETT.

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FOR

STUDENTS AND PRACTITIONERS.

BY

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PREFACE.

In presenting this volume to the friendly consideration of the Dental Profession, the best apology which the author can offer, is the entire absence of any text-book upon the subject of Dental Pathology, to which he could refer successive classes of dental students for reference or instruction. Under these circumstances, and at the request of those whose opinions are to be respected, this handbook has been prepared.

The author is conscious that some defects may be found in the present treatise. It has been prepared, during a large amount of professional and other labor. Should a second edition be required by the profession, any faults or omissions that may be discovered in it will be gladly corrected. The book is intended chiefly for students, and therefore is not burdened with extensive references to text-books or writers, upon whom the author has freely drawn, and to whom he is greatly indebted.

Boston, September, 1888.

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DENTAL PATHOLOGY.

PART I.

CHAPTER I.

In no branch of Medical Science is it more important to possess a clear and satisfactory knowledge of the conditions which are present in the state of health as well as of disease, than in the care and treatment of the mouth and teeth. The results of insufficient knowledge, careless examination, or error of judgment, in investigation of the oral organs are painfully evident to every eye, and the neglect of these important structures is sure to be followed by disastrous consequences.

ANATOMY.

The study of Pathology, whether of the dental organs or of other parts of the human organism, is so intimately connected with the other branches of medical science, that it is not possible to treat of that subject entirely independently, but its study must necessarily be associated with a knowledge of the branches with which it is so intimately connected.

The study of Dental Pathology can be prosecuted

only after a knowledge of anatomy and physiology; for the science of pathology consists mainly in the observation of the various ways in which the parts of the body, or the individual organs, have become changed from their normal condition to a diseased condition.

In order, therefore, to understand this change, it is necessary to possess a knowledge of the state of the parts or organs in a state of health. No extended description of the anatomical relations of the bones or other parts of the face will here be attempted; the student being supposed to have been sufficiently instructed in these fundamental branches of dental science before essaying to take up the study of Pathology. It is the less necessary to enter deeply into anatomical details in a work devoted mainly to another branch of dental study, because there are available to the student valuable books of reference upon these subjects, to which he may have recourse.

It will be remembered that the skeleton of the face is composed in great part of those osseous structures which, while they form the bony framework to which the soft parts are attached, which make up the general character of the face, and produce the features of the individual, also give lodgment or attachment to a great degree, to the various organs of mastication and deglutition; as well as to numerous glands and other structures connected with the important processes of preparing the food for digestion and assimilation.

The bones which form the maxillary apparatus of the upper and lower jaw give almost the entire form

and shape to the lower part of the face; and determine to a great degree the outline of the head as a whole. In various pathological conditions, especially in some forms of insanity, particularly in those of inherited or congenital character, the development of the bones of the face, and chiefly those belonging to the maxillary structures, is regarded as of great importance in judging of the nature and the gravity of the disease.

The superior maxillary bone, so-called, is to be considered as formed of several parts originally, which are fused together in later development, to form a single bony structure on each side. The shape of this bone is irregular, and is variously described, but perhaps it may be most correctly described as roughly pyramidal. The bone may be divided for purposes of study into a body and four processes—the nasal, malar, alveolar and palatine. The body of the bone is hollow, thus inclosing a cavity and forming the antrum of Highmore. The outer surface of the bone is irregularly pyramidal, the base of the pyramid being placed inward toward the cavity of the nose. The nasal process springs from the body, and has a direction upward in a vertical line with the canine tooth. The malar process is situated upon the outer surface of the bone, and forms the apex of the pyramid. It is characterized by great strength, and is of massive form, and articulates with the malar bone. The palate process forms a horizontal plate projecting inward from the body of the bone. It forms the roof of the mouth and the floor of the nose. The alveolar process is a strong

and broad ridge of bone which is curved to form the complete dental arch, when the bones of the opposite sides are united. Upon the outer surface of the alveolar process are eminences which correspond to the roots of the teeth, and considerable depressions exist between them. The prominence over the canine tooth is particularly marked.

There are four surfaces to be described in relation to the superior maxillary, viz., the external, the orbital, sometimes called the superior surface, the internal or nasal and the posterior or zygomatic. Upon the external surface is seen one of the notable landmarks of the facial anatomy, especially in relation to the diseases of this region, the canine eminence, situated over the root of the canine tooth. Just behind this eminence is a deep fossa, the canine fossa, which is one of the points of election for the puncture of the antrum in diseases of this cavity. Immediately beneath the margin of the orbit is seen a canal in the bone, the infra-orbital foramen, whence issues the infra-orbital nerve. This is one of the principal locations of neuralgic pain in the face, whether due to affections of the teeth or to other causes, and is the classical seat of *tic douloureux.* The orbital and nasal surfaces form the walls of the antrum in these directions. The zygomatic surface forms part of the zygomatic fossa. At its lower margin is a rounded eminence, the maxillary tuberosity, which lies behind the wisdom tooth. This portion of the bone is the seat of frequent pathological conditions due to faulty development of the bone or that of the teeth contained within its substance.

The superior maxillary bone articulates with nine bones, viz., with two of the cranium—the frontal and ethmoid—and seven of the face, viz., the nasal, malar, lachrymal, inferior turbinated, palate, vomer, and with the superior maxillary of the opposite side. Occasionally it is found to articulate with the orbital plate of the sphenoid. The bone also gives attachment to numerous muscles, which are concerned in the movements of the lower jaw, and other portions of the face; but no description of these structures will be here attempted.

The lower maxilla consists of a body and two rami, which ascend from the body at almost a right angle, at a point near its posterior extremity. The horizontal portion or body is curved upon itself somewhat in the form of a parabola, and presents a convex external and a concave internal surface, as well as an upper and a lower border. The upper border gives insertion to the teeth, and is called the alveolar ridge or alveolar process. The external surface is marked in the middle line by a slight prominence, the symphysis, which is the point of union of the two original halves of the jaw. This line extends from above downward, and usually is moderately prominent at the lower border of the bone, forming a tubercle called the mental prominence. The lower border of the jaw is thinner than the upper, and presents at its posterior portion, near the angle formed by the ramus, a slight depression, in which the facial artery is lodged, as it curves around the border of the bone to reach the cheek and side of the face. This notch forms a valuable

landmark in many of the operations of dental surgery, and should always be borne in mind. A rough and somewhat prominent line of bone is seen to pass from a point just external to the mental prominence, following a direction backward and outward and upward, till it reaches the upper border of the bone at a point directly behind the situation of the posterior molar tooth, where it is lost in the base of the coronoid process of the ramus. This is the external oblique line, and forms the point of attachment of several important muscles. Below the root of the second bicuspid tooth, on either side, is an orifice in the body of the bone, the mental foramen, the anterior extremity of the inferior dental or mental canal, which transmits the mental artery and nerve.

On the internal surface of the lower jaw, at the situation of the symphysis, may be seen four elevations, the genial tubercles, which are the seat of attachment of muscles concerned in the movements of the tongue, as well as in those of deglutition. These tubercles afford important points for the measurement of the jaw in cases of distortion or deformity of this bone, and are useful in defining the location of pathological changes in the bone or in the structures with which it is in relation. Below the genial tubercles is observed the commencement of a prominent line which runs in a direction outward, upward and backward, and terminates at a point near the centre of the ascending ramus on its inner surface, at the place where the inferior dental canal enters the body of the bone. The studies carried on by Mr. Tomes (see "Manual of Dental Anatomy," page 172

et seq.) would seem to show that the greater portion of the increase in the volume of the lower jaw which takes place between infancy and adult life is due to growth of the body of the bone at a point posterior to the location of the deciduous molar teeth, and that the additional teeth belonging to the second or adult denture are situated in entirely new bone, thus showing that the increase in length of the body of the jaw is principally due to the new formation of bone at a point behind the location of the second deciduous molar. The five anterior adult teeth thus occupy the whole of the space which contained the entire primary denture; the remaining teeth forming the additional number belonging to the permanent denture are implanted in new-formed bone, produced by the lengthening of the body of the lower jaw backward, by the recession of the ramus to a situation further back than it occupied in relation to the primary denture.

This portion of the jaw is frequently the seat of pathological conditions, connected with the development of the bone, or situated in the soft parts which there find attachment; as well as of many affections due to the defective development or unnatural growth, or other disturbed conditions of the teeth contained in this part of the jaw. This is particularly true of the wisdom teeth, which are frequently observed to be the seat of pathological conditions, either of developmental or of acquired character.

The angle which the rami of the jaw forms with its body is a variable one, according to the age and development of the individual. In infancy it is

quite obtuse, while in middle life it approaches a right angle, to become again more obtuse in mature life. As the development of the jaw advances from the primitive form which it possesses in the infant, and even more markedly in the fœtus, the ramus is much lengthened, and the two processes, the coronoid process and the articular condyle, are relatively increased in height and changed in shape.

The condyle in many animals forms a loose joint in its articulation with the temporal bone in the glenoid fossa, and is capable in these animals of extensive motions besides those of the hinge variety, by which the jaw is simply raised and lowered. In the cavity of the joint is found a thin plate of cartilage, which is attached to the borders of the articular cavity, where it is connected with the capsular ligament of the joint. This cartilaginous layer allows the condyle greater freedom of motion than is observed in a joint of ordinary character. The condyle of the jaw can be moved forward on to the eminentia articularis, as the tubercle at the front of the glenoid fossa is called, thus permitting a large degree of lateral motion in the jaw. This is in many classes of animals of much service in mastication. It finds its greatest development in the ruminants, or those animals which chew the cud. This motion is accomplished almost solely by the sliding of the condyle of the jaw forward upon the articular eminence, as above mentioned. In man the lower jaw possesses so great a degree of freedom of movement toward the articular eminence, that the condyle sometimes slips over the summit of the eminence and becomes

dislocated forward, the condyle lying in the zygomatic fossa. The mouth is then widely opened and cannot be closed, the chin is forced backward toward the neck, and all the parts are much distorted, and the deformity is very great.

The changes which the lower jaw undergoes after birth relate, first, to the alterations effected in the body of the bone by the primary and secondary dentitions, the loss of teeth in the aged, and the subsequent absorption of the alveoli; second, to the size and situation of the dental canal; and, third, to the angle at which the ramus joins the body of the bone. At birth the bone consists of two lateral halves, united by fibro-cartilaginous tissue, in which one or two osseous nuclei are generally found. The body is a mere shell of bone containing the sockets of the two incisors, the canine and the first molar teeth, imperfectly partitioned from one another. The dental canal is of large size, and runs near the lower border of the bone, the mental foramen opening beneath the socket of the first molar. The angle of the body and ramus is obtuse, from the jaw not being as yet separated by the eruption of the teeth. After birth, the two segments of the bone become joined at the symphysis, from below upward in the first year; but a trace of separation may be visible in the beginning of the second year, near the alveolar margin. The body becomes elongated in its whole extent, but more especially behind the mental foramen, to provide additional space for the three additional teeth developed in this part. The depth of the body becomes greater, owing to the increased

growth of the alveolar part to afford room for the roots of the teeth, and by thickening of the subdental portion, which enables the jaw to withstand the powerful action of the masticatory muscles; but the alveolar portion is the deeper of the two, and, consequently, the chief part of the body lies above the oblique line. The dental canal, after the second dentition, is situated just above the level of the mylo-hyoid ridge, and the mental foramen occupies the position usual to it in the adult. The angle becomes less obtuse, owing to the separation of the jaws by the teeth. In the adult the alveolar and basilar portions of the bone are usually of equal depth. The mental foramen opens midway between the upper and lower borders of the bone, and the dental canal runs nearly parallel with the mylo-hyoid line. The ramus is almost vertical in direction, and joins the body nearly at a right angle. In old age the bone becomes greatly reduced in size, for with the loss of the teeth the alveolar process is absorbed, and the basilar portion of the bone alone remains; consequently, the chief part of the bone is below the oblique line. The dental canal, with the mental foramen opening from it, is close to the alveolar border. The rami are oblique in direction and the angle obtuse.

The facial bones are intimately related to the transformations of the embryonic branchial arches, and to the branchial clefts. The median end of the first branchial arch projects inward from each side toward the large oral aperture. It has two processes the superior maxillary processes, which grow more

laterally toward the side of the mouth, and the inferior maxillary processes, which surround the lower margin of the mouth. From above downward there grows an elongation of the basis cranii, the frontal process, a broad process with a point at its lower and outer angle, the inner nasal process. The frontal and superior maxillary processes unite with each other in such a way that the former projects between the two latter. At the same time there is anchylosed with the superior maxillary process the small external nasal process, a prolongation of the lateral part of the skull, and lying above the superior maxillary process. Between the latter and the outer nasal process is a slit leading to the eye. The mouth is thus cut off from the nasal apertures which lie above it. But the separation is continued also within the mouth; the superior maxillary process produces the upper jaw, the nasal process, and the intermaxillary process (Goethe). The latter is present in man, but is united to the upper jaw. The intermaxillary bone, which in many animals remains as a separate bone (os incisivum), carries the incisor teeth. At the tenth week the hard palate is closed, and on it rests the septum of the nose, descending vertically from the frontal process.

The lower jaw is formed from the inferior maxillary process. At the circumference of the oral aperture the lips and alveolar walls are formed. The tongue is formed behind the point of union of the second and third branchial arches (His), while, according to Born, it is formed by an intermediate part between the inferior maxillary processes.

These transformations in the processes of development may be interrupted by a variety of causes acting upon the tissues at any period of their development. If the frontal process remain separate from the maxillary processes, then the mouth is not separated from the nose. This separation may be confined only to the soft parts, constituting hare lip, or it may involve the hard palate, constituting the varieties of cleft palate. Both conditions may occur on one or both sides. From the posterior part of the first branchial arch are formed the malleus (ossified at the fourth month) and Meckel's cartilage, which proceeds from the latter behind the tympanic ring, as a cartilaginous process, extending along the inside of the lower jaw almost to its middle. It disappears after the sixth month; still, its posterior part forms the internal lateral ligament of the maxillary articulation. Near where it leaves the malleus is the processus folii. A part of its median end ossifies, and unites with the lower jaw. The lower jaw is laid down in membrane from the first branchial arch, while the angle and condyle are formed from a cartilaginous process. The union of both bones to form the chin, occurs in the first year.

From the superior maxillary process are formed the inner lamella of the pterygoid process, the palatine process of the upper jaw, and the palatine bone, at the end of the second month, and, lastly, the malar bone.

The second arch (hyoid) arising from the temporal bone and running parallel with the first arch, gives rise to the stapes, the eminentia pyramidalis, with

the stapedius muscle, the incus, the styloid process of the temporal bone, the stylo-hyoid ligament, the smaller cornua of the hyoid bone, and, lastly, the glosso-palatine arch (His).

The third arch forms the greater cornu and body of the hyoid bone and the pharyngo-palatine arch (His).

The fourth arch gives rise to the thyroid cartilage (His).

CHAPTER II.

THE SALIVARY GLANDS AND SALIVA.

Among the most important structures contained within the oral cavity, both as regards the nutrition of the body, as well as in relation to the pathological processes which are observed in connection with the mouth and teeth, are the three bodies which provide the digestive secretions of the mouth, the Salivary Glands. They are located in the tissues about the cavity of the mouth, and are called the Parotid, the Submaxillary, and the Sublingual glands, respectively.

The Parotid gland is the largest of the salivary glands, weighing from half an ounce to one ounce. It lies upon the side of the face, immediately below and in front of the external ear. Its anterior surface is grooved to embrace the posterior margin of the ramus of the lower jaw, and advances forward to meet the ramus, between the two pterygoid muscles. Imbedded in its substance is the external carotid artery, which ascends behind the ramus of the jaw. The posterior auricular artery emerges from it behind, the temporal artery above, the transverse facial in front, and the internal maxillary winds through it inward, behind the neck of the jaw. It is traversed from behind forward, by the facial nerve and its branches, which emerge at its anterior border; the great auricular nerve pierces the gland adjoining

the facial, and the temporal branch of the inferior maxillary nerve lies above the upper part of the gland. The internal carotid artery and internal jugular vein lie close to its deep surface. The outlet of the gland is called "Steno's duct." It is about two and one-half inches in length. It communicates with the mouth by a small orifice situated opposite the second molar tooth of the upper jaw. The direction of the duct corresponds to a line drawn across the face about a finger's-breadth below the zygoma, from the lower part of the concha to midway between the free margin of the lip and the alæ of the nose.

The parotid saliva has an alkaline reaction, but during fasting, the first few drops may be neutral, or even acid, on account of free carbonic acid. Its specific gravity is 1003–1004. When allowed to stand it becomes turbid, and deposits, in addition to albuminous matter, calcium carbonate, which is present in the fresh saliva in the form of bicarbonate.

Salivary calculi are sometimes formed in the ducts of the salivary gland, owing to the deposition of lime salts, and they contain the traces of other salivary constituents; in the same way, this salt forms the tartar of the teeth, which contains many threads of leptothrix, and the remains of low organisms which live in decomposing saliva and other putrefactive substances in carious cavities between the teeth.

The Submaxillary gland is situated below the jaw, in the anterior part of the submaxillary triangle of the neck. It is irregular in form, and weighs

about two drachms. The facial artery lies in a groove in its posterior and upper border. The gland communicates with the mouth by "Wharton's Duct," which is about two inches in length, and opens by a narrow orifice on the summit of a small papilla at the side of the frænum linguæ. The submaxillary saliva is alkaline, and may be strongly so. When allowed to stand for some time, fine crystals of calcium carbonate are deposited, together with an amorphous albuminous body. It always contains mucin, which may be precipitated with acetic acid; hence it is usually somewhat tenacious. Further, it contains ptyalin, but in less amount than in parotid saliva.

The Sublingual gland is the smallest of the salivary glands. It is situated beneath the mucous membrane of the floor of the mouth on either side of the frænum linguæ, in contact with the inner surface of the lower jaw, close to the symphysis. It is narrow, flattened, in shape something like an almond, and weighs about a drachm. Its excretory ducts, of which there are several, open separately in the mouth, on the elevated crest of the mucous membrane caused by the projection of the gland on either side of the frænum linguæ. The sublingual saliva is strongly alkaline in reaction, very sticky and cohesive, contains much mucin and numerous salivary corpuscles.

The salivary glands are conglomerate glandular structures, consisting of numerous lobes, which are made up of smaller lobules connected together by dense areolar tissue, vessels and ducts. In the sub-

maxillary and sublingual glands, the lobes are more loosely united than in the parotid.

The salivary glands may be divided into different classes according to the nature of their secretions. 1. The serous or albuminous (true salivary) glands, whose secretion contains a certain amount of albumin, as the human parotid. 2. The mucous glands, whose secretion, in addition to some albumin, contains the characteristic constituent, mucin. 3. The mixed (muco-salivary glands), some of the acini secreting albumin, and others secreting mucin, as the human submaxillary gland.

The most important part played by the saliva in the process of digestion, is its diastatic or amylolitic action; that is, the transformation of starch into dextrin and some form of sugar. Saliva dissolves those substances which are soluble in water, while its alkaline reaction enables it to dissolve some substances which are not soluble in water alone, but require the presence of an alkali. Saliva moistens dry food, and aids the formation of the bolus, while by its mucin it aids the act of swallowing, the mucin being given off unchanged in the fauces. The ultimate fate of the ptyalin is unknown. Saliva also aids articulation, while, according to Liebig, it carries down into the stomach small quantities of oxygen. It is necessary, to the sense of taste, to dissolve sapid substances, and bring them in relation with the end-organs of the nerves of taste.

The secretion of saliva is diminished during inflammation of the salivary glands; occlusion of the ducts by concretions (salivary calculi), also by the

use of atropine, daturine, and during fever, whereby the secretory (not the vasomotor) fibres of the chorda appear to be paralyzed. Mercury and jaborandi cause secretion of saliva, the former causing stomatitis, which excites the secretion of saliva reflexly. Even diseases of the stomach accompanied by vomiting cause secretion of saliva. The reaction of saliva is acid in catarrh of the mouth, in fever, in consequence of decomposition of the buccal epithelium, and in diabetes mellitus, in consequence of acid fermentation of the saliva, which contains sugar. Hence diabetic persons often suffer from carious teeth.*

Unless the mouth of an infant be kept scrupulously clean, the saliva is apt to become acid.

The older observers regarded the saliva as a solvent, and in addition, many bad properties, especially in starving animals, were ascribed to it. This arose from a knowledge of the infectious qualities of the saliva of rabid animals, and the parotid saliva of poisonous snakes. Human saliva, without organisms, is poisonous to birds. The salivary glands have been known for a long time. Galen was acquainted with Wharton's duct, and Ætius with the submaxillary and the sublingual glands. Saliva was obtained for purposes of analysis from a horse in 1780, and in this year was made the first artificial salivary fistula. Spallanzani asserted that food mixed with saliva was more easily digested than food mixed with water. Hamburger and Siebold investigated the reaction,

* See chapter on "Caries."

consistence and specific gravity of saliva, and found in it mucus, albumen, common salt, calcium and sodium phosphates.

PATHOLOGICAL CONDITIONS AFFECTING THE SALIVARY GLANDS, AND THE EFFECT OF POISONS UPON THESE STRUCTURES.

Certain affections, such as inflammation of the mouth, neuralgia, ulcers of the mucous membrane, affections of the gums due to teething, or the prolonged administration of mercury, often produce a copious secretion of saliva (ptyalism).

Certain poisons cause the same effect by direct stimulation of the nerves, as Calabar Bean, Digitalin, and especially Pilocarpin. Many poisons, especially the narcotics, above all atropine, paralyze the secretory nerves, so that there is cessation of the secretion, and the mouth becomes dry; while the administration of muscarine, in this condition, causes renewed secretion. Pilocarpine acts on the chorda tympani, causing a profuse secretion, and, if atropine be given, the secretion is again arrested. Conversely, if the secretion be arrested by atropine, it may be restored by the action of pilocarpine and physostigmin. Nicotine in small doses excites the secretory nerves, but in large doses paralyzes them. In this way we account for some of the results of the use of tobacco, as manifested by its action on the salivary glands.

CHAPTER III.

STRUCTURE OF THE TEETH.

A tooth is a papilla of the mucous membrane of the gum, which has undergone a characteristic development. In its simplest form, as in the teeth of the lamprey, the connective-tissue basis of the papilla

FIG. 1.

A FOLLICLE OF MUCOUS CELLS EXTENDING FROM THE DENTAL RIDGE TO THE ENAMEL GERMS OF THE MILK AND PERMANENT TEETH; FROM A HUMAN EMBRYO OF THREE MONTHS' GROWTH.

The cells of the mucous layer of epithelium dip down into the substance from the dental groove (*a*) of an incisor of the lower jaw, and resemble, somewhat, a tubular gland with lateral offshoots At about the middle of the follicle, which is lined throughout with cylindrical cells, it is connected by a transverse process (*b*) with the external epithelium of the enamel organ, the spongy layer of which is represented (*c*). The inferior closed portion of the follicle is the enamel germ of the permanent incisor tooth. Magnified 80 diameters.

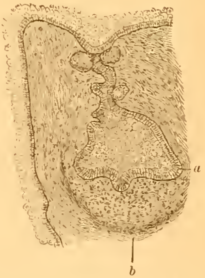
is covered with many layers of corneous epithelium. In human teeth, part of the papilla is transformed into a layer of calcified dentine, while the epithelium of the papilla produces the enamel; the fang of the tooth being covered by a thin accessory layer of bone, the crusta petrosa, or cement. The pulp in a fully-grown tooth represents the remainder of the dental papilla, around which the dentine was deposited. It consists of a very vascular, indistinctively fibrillar connective tissue, laden with cells. The layer of cells, resembling epithelium, which lie in direct contact with the dentine, are called Odontoblasts, that is, those cells which build up the dentine. These cells send off long branched processes into the dental tubules, while their nucleated bodies lie on the surface of the pulp and form connections by filaments with other cells of the pulp and with neighboring odontoblasts. Numerous non-medullated nerve fibres (sensory, from the trigeminus), whose mode of termination is unknown, occur in the pulp. The periosteum, or peridental membrane of the root, is at the same time the alveolar periosteum, and consists of delicate connective tissue, with few elastic fibres and many nerves.

DEVELOPMENT OF THE TOOTH.

The development of the tooth begins at the end of the second month of fœtal life. Along the whole length of the fœtal gum is a thick, projecting ridge, composed of many layers of epithelium. A depression, the dental groove, also filled with epithelium, occurs in the gum, and runs along under the ridge.

The dental groove becomes deeper throughout its entire length, and on transverse section it presents the appearance of a dilated flask, while at the same time it is filled with elongated epithelial cells, which form the "enamel organ." A conical papilla (dental germ) grows up from the mucous tissue below the epithelium, of which the gum at this time consists, toward the enamel organ, so that the apex of the

FIG. 2.

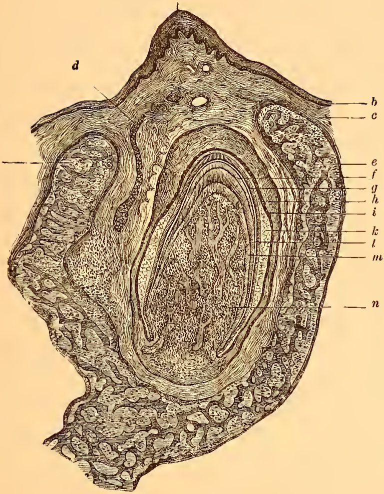


ENAMEL GERM OF LOWER BICUSPID FROM EMBRYO OF A CALF.

The cells lining the walls of the follicle have a cylindrical form (*a*). The cells of the interior are small and flattened The rudiment of the dental sac is indicated by a shaded outline (*b*). Between *a* and *b* the rudiment of the dentine is elevated into papilliform processes. Magnified 80 diameters.

papilla comes to have the enamel organ resting on it like a double cap. Afterward, owing to the development of the connective tissue, the parts of the enamel organ lying between the individual dentine germs disappear, and gradually the connective tissue forms a tooth sac, inclosing each papilla and its enamel organ. The cement is formed from the soft connective tissue of the dental alveolus.

FIG. 3.



SAGITTAL SECTION OF A LOWER JAW FROM THE EMBRYO OF A DOG, SHOWING AN INCISOR WITHIN ITS DENTAL SAC.

(*a*) Facial lip of the dental ridge; (*b*) epithelium; (*c*) corium, with papillæ in the dental ridge, and cavities of transversely divided vessels; (*d*) enamel germ of the permanent incisor containing an aggregation of epithelial cells; its connection with the enamel organ of the deciduous tooth does not appear in the section; (*e*) anterior, (*e'*) posterior, osseous lamella of the jaw with rounded summits; (*f*) completed enamel of the dental cap; in the section it is separated, somewhat, from the (*g*) layer of enamel cells; (*h*) retiform connective tissue of the dental sac; (*i*) outer epithelium of the enamel organ completely investing the papillæ of the dental sac; (*k*) spongy layer of the enamel organ; (*l*) completed dentine of the cap; (*m*) layer of dentinal cells; (*n*) dental pulp with wide vessels in its interior. Magnified 20 diameters.

DENTITION.

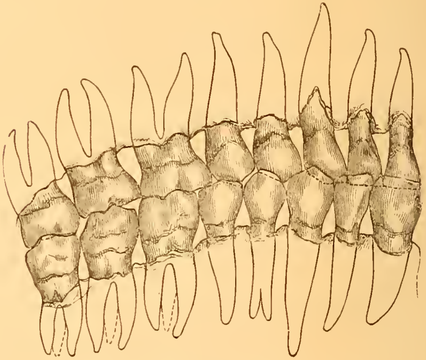
During development of the first, temporary, deciduous or milk teeth, another special enamel organ is formed near the primary teeth, but it does not undergo development until the milk teeth are shed.

Even the papilla is wanting at first. When the permanent tooth is beginning to develop, it opens into the alveolar wall of the milk teeth from below. The tissue of this dental sac causes erosion or eating away of the fang, and even of the body of the milk teeth, without its blood vessels undergoing atrophy. The chief agents in the absorption of the deciduous teeth are the amœboid cells of the connective tissue.

ERUPTION OF THE TEETH.

The following is the order in which the twenty milk teeth cut the gum. From the seventh month

FIG. 4.

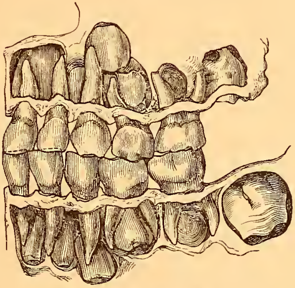


THE NORMAL PERMANENT DENTURE.—*From Wedl.*

to the second year; lower central incisors, upper centrals, upper lateral incisors, lower lateral incisors, first molars, canines, second molars. The permanent

teeth succeed the milk teeth, the process beginning about the seventh year. Ten teeth in each jaw take the place of the milk teeth, while six teeth appear further back in the jaw. Thus the total number of the permanent teeth is thirty-two. As the sacs from which the permanent teeth are developed are formed before birth, the teeth of the second denture merely undergo the same process of development as the tem-

FIG. 5.



THE NORMAL PRIMARY DENTURE, SHOWING THE DEVELOPING TEETH OF THE SECONDARY DENTURE IN THE ALVEOLAR PROCESS.

porary teeth, only at a much later period. The last of the permanent molars, "the wisdom tooth," may not cut the jaw until the 17th to the 25th year. At the sixth year the jaw contains the largest number of teeth, as all the temporary teeth are present, and in addition the crowns of all the permanent teeth, except the wisdom tooth, making forty-eight in all.

NUTRITION.

The taking of food may be interfered with by spasm of the muscles of mastication (usually accompanied by general spasm of the entire body), stricture of the œsophagus by cicatrices after swallowing caustic fluids, or from syphilis, or caused by the presence of a tumor, such as cancer. Inflammation of any kind interferes with the taking of food. Impossibility of swallowing occurs as part of the general phenomena in diseases of the medulla oblongata in consequence of paralysis of the motor centres, "superior olivary processes," for the facial, vagus and trigeminus. Stimulation or abnormal excitation of these parts causes spasmodic swallowing and the feeling of a constriction in the neck, (globus hystericus).

The Hippocratic School was acquainted with the vessels of the teeth; Aristotle ascribed an uninterrupted growth to these organs, and he further noticed that animals which were provided with horns, and had cloven hoofs, had an imperfect set of teeth—that the upper incisors were absent. It is curious to note that in some cases in which men have had an excessive formation of hairy appendages, the incisor teeth have been found to be imperfectly developed. The muscles were known at an early period. Vidius described the temporo-maxillary articulation with its meniscus in 1567.

CHAPTER IV.

ABSORPTION OF THE DECIDUOUS TEETH.

The processes of absorption of any tissue are in some ways similar to those observed in certain inflammatory affections. In inflammation of the hard tissues, in other parts of the body, there is noticed an action upon the bony materials by which they are slowly separated from the mass of hard tissue in their vicinity, and are at length either reduced to a form in which they may be taken up and removed by the natural organs of circulation, or they may be removed in part by absorption, and the remainder may be extruded from the place it occupied in the tissues, thus completing the removal of the substance from the body. All the hard tissues of the body are everywhere permeated by delicate filaments of connective tissue, which carry on the functions of nutrition in the part, and are the means of preserving its vitality. This is true in the teeth as well as in other forms of hard animal tissue, and may be traced into the finer canals of the dentine, and has been thought to penetrate even the structure of the enamel.

The processs of absorption of a temporary tooth commences at the apex of the root, in cementum which has heretofore shown no indications of any tendency to disease. The first recognizable step in the process of the physiological removal of the primary teeth is found in a roughness of the cementum,

a corrugation of the exterior of the root, with the solution, or at least the softening, of the surface of the cementum thus affected. This diminution of the firmness of the dental textures is then followed by the entire removal of the tissue at the root of the tooth and a progressive advance of the process of absorption toward the mucous membrane, until there remains only the margins of the gum to afford attachment to the crown of the tooth, the radical portion having entirely disappeared from the jaw.

The exciting cause of the normal absorption of the tissues of the milk tooth is the approach of the secondary or permanent tooth in the course of its development. The second tooth, growing from its papilla in an upward direction toward the position it is to occupy in the alveolar process, comes into immediate proximity with the root of the deciduous tooth. The continued increase in the development of the secondary tooth is the cause of active phenomena at the apex of the root of the deciduous tooth, which resemble in many respects those of a moderate inflammation of the root. The result is a gradual reduction in the volume of the root, which is in an exact relation to the advance of the crown of the permanent tooth, so that at the time when the deciduous tooth is ready to be extruded from the jaw, the crown of the permanent tooth which is to succeed it is often visible in the depression left after extraction of the remains of the milk tooth.

The manner in which the absorption of the root of the milk tooth is accomplished has been the subject of careful study, and many theories have been

advanced to explain this singular phenomenon. The most celebrated investigators in the domain of dental science have given the subject much attention. Czermak, Bodeker, Tomes, and, more recently, Abbott (see *Independent Practitioner*, July, 1884) have made valuable contributions to the solution of the question, which, however, cannot yet be said to be absolutely settled. All observers unite in describing the gradual excavation or corrugation of the hard textures of the root of the tooth, very similar to the appearances noticed in the absorption of portions of ivory, surgical catgut, silk, etc., when brought into relation with the textures of the living and healthy organism. The substance of these materials is invaded by numerous cavities, in which a softened and jelly-like content is found, and which penetrates further and further into the textures of the tissue. The advance of the process of softening is followed by continuous absorption of the disintegrated textures of the tooth, and in this way is brought about the removal of the entire radical portion of the dental structures. There is no attending suppuration in the process of absorption, and the entire course of the process is devoid of pain. There is often a certain amount of redness and swelling of the soft structures about the neck of the deciduous tooth during the process of absorption, but this may well be due, in part at least, to the irritation of the tissues about the part, caused by pressure upon the shortened and loosened deciduous tooth, and also to the natural tendency to vascularity accompanying any process of growth or development. The process of natural absorption of dentinal tissues

bears no relation to caries of these textures. This event is one of natural removal of normal structures. Caries is the pathological degeneration of the same structures by means of disease, and is accompanied, if not caused, by chemical action, and is universally the seat of disorganization of the tissues of the tooth; it is also accompanied by the presence of bacterial organisms, and usually also by the putrefaction of the products of the disorganization of the tooth substance. Caries takes its rise at all times from without. Absorption progresses from the apex of the root. Absorption is accompanied by a new formation of medullary or myxomatous tissue, which invades the tooth structure and changes it into a material which can be taken up by the natural channels of the part. In caries the softening is caused by the chemical decomposition of the calcified textures of the tooth-structure, is accompanied by putrefaction and the presence of microörganisms. In physiological absorption there is simple removal of the softened tissues without the occurrence of putrefaction or the presence of microörganisms. Further researches in the domain of absorption of the hard tissues, and especially those of the deciduous teeth, are greatly needed, and it is to be hoped that from such studies the obscure points in relation to the physiological removal of the hard tissues may be elucidated.

CHAPTER V.

SECONDARY DENTITION.

The phenomena associated with the disappearance of the first teeth, and their replacement by the teeth of the permanent denture, form one of the most interesting and important studies connected with the oral organs. The pathological conditions arising from any derangement of this process, or connected with any disease of the parts involved, form a separate and distinct group, of unique character. As is well known, the primary denture is developed in the early months of infantile life, and is composed of teeth of small size, contained in a dental arch of comparatively limited capacity. The teeth thus formed are sufficient to fill the arch of the infantile mouth, and form a complete dental formula for that period of the life of the individual. As the body of the child is developed, and every part and organ is advancing to a greater size, with the adult development of the organism, the dental arch is enlarged, and the entire outline of the lower part of the face is changed in all its proportions. The teeth which were sufficient for the earliest years of life are no longer adequate for the purposes of the adult frame, and the jaw has become so much larger that the teeth are in comparison dwarfed and weazened, and in no sense suffice for the requirements of the organism. The extent of the change which has

occurred is not easily appreciated by the observer, unless occasion should offer for a comparison of the relative proportions of the jaw and the contained teeth. In some cases in which the normal development of the second denture has been interrupted, the teeth of the first denture are retained long after the time when they should have been physiologically replaced by those of the permanent set. Under such conditions we may sometimes find the infantile teeth of the primary denture still retained in the alveolar process of the mature jaw, they, of course, retaining their original size and shape, while the teeth of the second denture on either side of them are large and massive. The retained primary teeth are often preserved until advanced life, they seeming to possess a similar degree of vitality to that of the permanent teeth by which they are surrounded.

One of the chief results of their detention in the adult jaw is the restricted development of the dental arch, which should normally be symmetrically enlarged in all directions to accommodate the increased number of teeth belonging to the secondary denture, each tooth of which is also of larger size than those of the primary denture. If, therefore, the teeth of the first denture are retained in the dental arch of the subject beyond the period when they should normally give place to the members of the second denture, two principal pathological conditions are induced in the jaw, each of which contributes to the permanent deformity of the facial region and to the impairment of the physiological functions of the oral organs.

The retention of the small infantile teeth in the massive jaw of adult development is associated with the restricted growth of the alveolar process within the area of the infantile teeth. The alveolar process is developed in proportion to the teeth which it is to contain, and it is often observed that if the teeth of the first denture are indefinitely retained in the jaw, the alveolus is restricted in its development to the size required for the accommodation of the teeth actually contained in the jaw. The normal and symmetrical enlargement of the jaw to correspond with the increasing size of the adult structures generally, does not occur in the mouth when the members of the primary denture are unduly or permanently retained in the alveolar process. The consequence of this is that the alveolar process in the region of the retained teeth is usually shorter than normal, being restrained in its development to the size requisite for the teeth actually contained in the jaw, and not acquiring the size which would have been reached had normal development occurred.

The effect of the retention of the deciduous teeth is to diminish the size of the arch of the alveolus, so that it is only sufficient for the teeth actually contained in the jaw, and does not at all conform to the development of the adjacent structures of the head and face. The result of this is seen in a pointed form of the jaw, a narrowing of the lateral measurements of the alveolar arch, and often a sinking backward of the entire contour of the lower portion of the face. The chin becomes sharp and pointed, the lower teeth are sometimes placed far behind the upper, the facial

outline retreats in a marked manner from the nasal process of the superior maxillary, so that at times a line drawn from the base of the nasal cartilage to the prominence of the cricoid cartilage of the larynx will not touch the chin or the lower lip. The deformity thus produced is very marked, and is usually irremediable.

The second effect produced by the retention of the deciduous teeth is the interference with mastication and speech. For the proper execution of each of these important functions it is necessary that there should be accurate closure of the dental organs, and correct apposition of the upper with the lower members of the denture. The teeth of the primary denture are so diminutive that they cannot make a useful contact with those of the normal secondary denture, and therefore the act of mastication is imperfectly performed; if indeed these organs can properly be called organs of mastication. The speech is affected from the inability to close the anterior opening of the mouth by the teeth, and thus is produced a lisping articulation, similar in some respects to that observed in the pronunciation of certain consonant sounds in persons with a cleft in the hard or soft palate.

The phenomena attending the disappearance of the deciduous teeth, and their replacement by those of the permanent set, are among the most curious to be observed in any of the physiological processes of the human body. The development of the deciduous teeth from the primary dental follicle and the primitive enamel germ has already been briefly

alluded to in another place. It was also stated that from the dental germ of the deciduous tooth a prolongation of the substance of the dental follicle was given off, which remained dormant in the alveolar process during a great part of the time while the deciduous teeth were in existence, but which at length began to develop, and produced the teeth of the permanent denture; being developed gradually, and appearing at intervals in the jaw, the last teeth being erupted at about the eighteenth to the twenty-fifth year. The manner in which the disappearance of the primary denture is brought about has long been the object of study by histologists, but the process is one which is clothed with more than usual obscurity, and its investigation has been attended with great difficulty. From the best observations, however, it is now possible to outline the physiological course of events somewhat as follows, though the investigations of many competent observers are not wholly in accord upon the subject. It may also be added that the results thus far obtained and the opinions thus far formed are founded upon the basis of *experimental pathology* fully as much as upon the observation of the physiological occurrences accompanying the loss of the temporary teeth.

It is well known that if certain substances are introduced into the tissues of the human body and are allowed to remain there, the system not only retains them, but is not seriously disturbed by their presence.

Thus, in certain cases of fracture of the long bones, in which for some reason the ends of the broken bone

have failed to unite, it has been customary to drive ivory pegs into the ends of the bones, in order to excite the parts to renewed activity, and thus encourage the union of the fracture. In many instances it has been observed that those portions of the ivory which were included in the bony tissue have been entirely removed by the action of the tissues of the part, and there has remained only that portion of the ivory which was outside the bone. The disappearance of the ivory is due to the absorption of the substance, to the dissolution of the ivory by the natural processes of the body, and its removal in the form of soluble or oxydizable compounds. Again, in cases of fracture in which the process of healing goes on in the ordinary manner, there is first formed a large mass of hard material about the ends of the fractured bone, which incloses them in much the same manner as a plumber incloses the ends of a pipe, which are to be united, in a thick mass of solder. The tissue which is thrown out about the ends of the broken bone is called "callus," and serves to hold the ends of the bone in apposition one with the other, and to prevent their displacement in any direction. When the ends of the bone have thus been cemented together by this large mass of callus on the outside, the process of union of the broken ends commences in the tissues of the bone, and is carried on until the point of fracture has been fully healed. When this has been accomplished, and the bone is strong, then the callus, which had been thrown out in order to support the parts during the process of healing, is removed by gradual absorption,

and after a time there is no trace of it to be discovered. If, by any chance, the bone has united in a faulty manner, as is at times the case, so that a sharp angle is formed at the point of union, we find that after a time the sharp corner is removed and the surface is smoothly rounded by the absorption of the superfluous material, and the contour of the bone is made smooth and even. So, too, after amputation of a long bone in one of the limbs, it is uniformly observed that the end of the bone is gradually rounded and smoothed by the process of absorption of the sawed edges, and the growth of a covering of bone over the open end of the medullary cavity. Thus we see that nature possesses the power to produce considerable amounts of hard material in cases of repair of the tissues of the bones, and that such deposits of hard tissue may afterward be easily and completely removed from the place where they were deposited, and the part restored to its former condition.

CHAPTER VI.

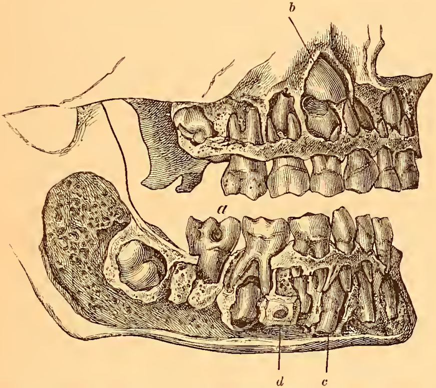
DEVELOPMENT AND ERUPTION OF THE SECONDARY DENTURE.

In the processes attending the shedding of the primary teeth, and their replacement by the members of the permanent denture, we may notice the same peculiarity which has been observed in regard to the long bones in other parts of the body.

At a period subsequent to the development of the deciduous teeth, the germs of the secondary dental follicles, which have been deposited by the dental follicles of the first dentition in the alveolus of the upper and the lower jaw, become active. Soon there is seen the appearance of tooth structure, and at a later period there are unmistakable evidences of the formation of complete dental organs of a larger size and more massive structure than those already in the jaw. As the new teeth are formed, they advance in the jaw toward the surface of the alveolar process. In their progress they soon come to be placed directly under the bodies and roots of the deciduous teeth which already occupy the jaw. As the secondary teeth advance in direction, and encroach more and more upon the structure of deciduous teeth, the roots of these teeth are seen to diminish in length, and to undergo a loss of substance from the absorption of their extremities and removal of their tissues, so that at last, at the time when the milk teeth are shed, or

are become so loose as to require extraction at the hands of the dentist, there remains nothing but the crown, and a little border of the submucous surface of the deciduous tooth, which is held in position only

FIG. 6.



SET OF MILK TEETH, WITH THE CORRESPONDING PERMANENT TEETH STILL IMBEDDED WITHIN THE JAW.

The first permanent molars (*a*) have already emerged from the jaw, both above and below, so that the second dentition has commenced. Profile view from the right side. The somewhat inclined crowns of both permanent incisors are visible behind the extremities of the roots of the milk incisors. The crown of the upper canine tooth (*b*) presents a marked inclination, and is situated high up in its alveolus; the lower permanent canine (*c*) likewise occupies a deep position. The crowns of the permanent bicuspids are grasped by the diverging roots of the milk molars. The mental foramen (*d*) is seen between the first and second milk teeth. The crowns of the second permanent molars, inclosed within their alveoli, are imbedded in the maxillary tuberosity and coronoid process. Natural size.

by the attachments of the mucous membrane. On removing a tooth so loosened, the crown of the permanent tooth may often be seen already appearing in the place formerly occupied by the deciduous

tooth, the advancement of which has caused the physiological absorption and removal of the root of the deciduous tooth, and in this way brought about the *physiological loss* of these first dental organs, in order to provide a location for the permanent denture, which is in size and structure adapted to the requirements of the adult body during the lifetime of the individual.

In the occurrence of the second dentition we have a totally different dental formula from that observed in the primary dentition. The second or permanent denture contains representatives of all the teeth of the primary denture, and in addition to these we find three teeth upon each side of the median line, which were not represented at all in the primary denture. The jaw is also much larger and the alveolar ridge relatively elongated in the adult. If now we take the jaw of a child, in which the complete primary denture is present, and apply it to the jaw of an adult, containing all the teeth of the permanent denture, we shall find that the entire infantile jaw corresponds to that part only of the adult jaw which is comprised in that portion of the adult denture consisting of the incisors, the canines and the two bicuspids, or premolars. The remaining portion of the adult denture has no development in the infantile jaw, and is located beyond the area of the alveolus in the mouth of a young child. Careful investigation upon the position of the teeth in the deciduous and in the permanent denture, made by Tomes and others, seems to demonstrate that the additional teeth of the adult denture are placed in

that portion of the alveolar process which has been developed behind the location of the members of the deciduous denture. It is thought that the coronoid process of the lower jaw moves gradually backward, and that the alveolar process is thereby elongated so as to afford space for the additional teeth of the adult denture, and that the coronoid process has thereby occupied every position between the location of the first molar tooth and that which

FIG. 7.

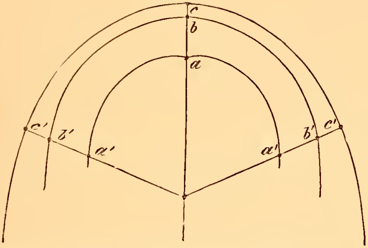


DIAGRAM ILLUSTRATING THE CHANGES IN THE DENTAL ARCH DURING THE GROWTH OF THE UPPER JAW.—*After Wedl.*

(*a*), lowest point in the junction of the anterior portions of the two segments of the upper jaw, from a fœtus in the seventh month; (*b*), central point of the space between the edges of the two central incisors of a set of milk teeth; (*c*), the same of a permanent set.

it finally assumes when the development of the denture is at length complete. Thus it would seem that the enlargement of the jaw, and its augmented alveolar space is provided by the gradual retreat of the coronoid process to a position further and further backward, and in the space so provided, the additional teeth of the adult denture, which are all molar teeth, find place in the jaw.

The origin of the molar teeth, by which is meant those teeth which are additional to the number contained in the primary denture, has long been an unsettled question, and it is not yet certainly known how they are produced. The most commonly accepted theory at present is something like the following: The deciduous teeth at the time of their

FIG. 8.

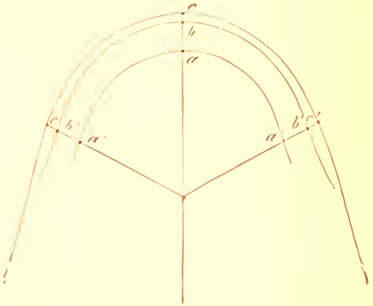


DIAGRAM ILLUSTRATING THE CHANGE IN THE DENTAL ARCH DURING THE GROWTH OF THE LOWER JAW.

(c), the highest point in the line of junction of the anterior surfaces of the two segments of the lower jaw in a fœtus of seven months. The rest of the letters indicate corresponding points with those in the last figure. Natural size.

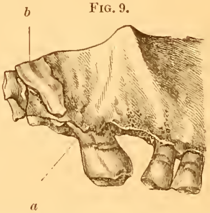
development in the infant, send off germs from the dental follicle, which serve as the origin of the dental follicle for the permanent teeth. Each of the deciduous teeth thus provides for the development of its succeeding permanent tooth. The posterior infantile molar thus sends off the germ for the second bicuspid, of the permanent denture. It is also

thought to give off a germ for the development of the first permanent molar, which appears immediately behind it at about the seventh or eighth year. The first molar in the same way sends off a germ for the development of the second molar, and this in its turn gives off a germ for the development of the third molar or wisdom tooth, which usually appears at about the twentieth year.

The correctness of the conclusions here advanced in relation to the origin of the additional teeth of the adult denture is strikingly confirmed by the study of certain pathological conditions associated with the second denture. In certain cases the full denture fails to appear in the mouth, one or more teeth failing to erupt, and the jaw is not infrequently the seat of more or less distortion and deformity. Further, there is often a sinus leading from the surface of the mucous membrane of the gum into the tissues of the part. When this condition exists, there is usually also a continuous and offensive purulent discharge from the opening of the sinus, which causes great distress to the patient and seriously endangers the health. A probe inserted into the sinus will often touch necrosed or denuded bone. In many instances the adjacent molar tooth is also the seat of pain, or is loosened or otherwise impaired in its integrity. In more than one instance in which such cases have been observed by the writer, and operation has been advised, it has been found that the distortion was occasioned by the presence in the jaw of a distorted and malformed tooth, which was intimately fused with the body of the second molar below the level of

the mucous membrane. It is probable that in the development of the germ for the third molar, the normal process was in some way disturbed, and the germs of the second and third molars were in contiguity. The development of the second molar was accomplished without interruption, but when the third molar was developed at a later period, the growing germ was brought into so close relationship with the structure of the second molar that fusion of

Fig. 9.



AN OBSTACLE TO THE DESCENT OF THE RIGHT UPPER WISDOM TOOTH, IN A FACIAL VIEW OF THE POSTERIOR SEGMENT OF THE UPPER JAW.—*From Wedl.*

The first molar was detached some time previously; the second is inclined anteriorly, and the extremity of the posterior facial root (*a*) has a corresponding deviation posteriorly, and presses against the descending masticating surface of the wisdom tooth, the facial surface of which (*b*) has been exposed by the removal of the alveolar wall. Two-thirds natural size.

the two occurred, with the subsequent distortion of the growing tooth and its retention as a misshapen mass of confused structure, firmly attached to some part of the adjacent tooth. As the deformed tooth grew larger, it caused absorption of the thin layer of alveolar process above it, and the mucous membrane which then covered it was perforated, thus allowing free communication between the cavity of the mouth and the retained tooth. The intrusion of particles

of food or other substances into the cavity containing the tooth would naturally be followed by suppuration, and there would be a constant discharge from the orifice of the cavity. In the cases seen by me there was subsequent inflammation of the alveolar process, with implication of the neighboring tooth, which became painful and tender. On endeavoring to examine the condition of the alveolus, a hard and smooth body was uniformly felt in the jaw, inclosed in a bony cavity, which presented rough and jagged walls. It was in each case necessary to enlarge the opening which led down to the offending body, by removing a portion of the alveolar wall, when it could be plainly observed that the cause of the trouble was a retained tooth, usually much distorted, and bearing no resemblance to the normal shape or structure of a molar tooth. When the retained tooth was fused to the root of the second molar, there was generally an extension of the inflammatory process to this tooth, and the patient usually presented himself for the purpose of having the second molar removed. In no case of this kind was there an erupted third molar present in the jaw, and in no case was there any history of the loss of that tooth by extraction or disease. On endeavoring to extract the affected tooth, when this was done, it was found impossible to remove it, and on subsequently opening the alveolus behind the body of the tooth, as was generally advised, a glistening white body was exposed, which could be moved by the exercise of force, and was observed to cause a movement of the adjacent second molar. On again attempting the

extraction of the second molar, it was easily accomplished, with the removal of the attached third molar. Three specimens in my possession illustrate in a very complete manner the deformity here described, and show the way in which the misplacement of the germs of the second dentition may produce pathological conditions in the denture, which have for their result the loss of important organs. The facts observed in this condition also indicate that the

FIG. 10.

UNION OF THE ROOTS OF THE UPPER SECOND MOLAR ON THE LEFT SIDE, WITH THOSE OF THE WISDOM TOOTH, AS SEEN FROM THE FACIAL SIDE.

The posterior facial root of the second molar, which has been filed away to show the root canal, impinges upon the anterior facial root of the wisdom tooth, and is united to it by means of cement; in the same manner, the lingual root of the second molar is united with the anterior facial root of the wisdom tooth by means of a quite thick layer of cement. These teeth were extracted on account of chronic inflammation of the root-membrane and suppuration of the gum. Natural size. (For the use of this specimen the author is indebted to Dr. Jurié Gustav.)

germ for the third molar tooth is derived from the dental follicle of the second tooth, and is liable to fusion with this tooth in case any accidental disturbance of its normal location in the jaw, or in its development afterward, should arise.

In some cases the retained tooth may pierce the inner or the outer table of the jaw, and may then be followed by an abscess in the soft parts, which

may open by an independent orifice upon the surface of the face. When the retained tooth is contained within the upper jaw, it may perforate the floor of the nose, and thus give rise to the signs of disease of this cavity, either in the general fossa of the inferior meatus, or in the antrum. This condition may become serious from the reason that a canal is opened by which fluids or other substances may pass from the cavity of the mouth into that of the nose, thus keeping up the diseased condition indefinitely. Extraction in these cases is then followed by a naso-buccal fistula, which may cause both the patient and the dentist much annoyance. At times, when the retained tooth is not attached to the other teeth, it may ascend bodily, and be extruded into the nasal fossa, or into the antrum. This accident is often followed by the symptoms of suppurative disease of this cavity, and when the wall of the antrum is punctured for its relief, the tooth may be found lying in a mass of granulations, which have sprung up around it. The removal of the offending body may not be followed by relief in all cases, owing to the diseased condition of the surrounding structures, which has been occasioned by the prolonged irritation caused by the gradual extension of the tooth through the nasal mucous membrane, and its retention in abnormal relations, and the irritation of the delicate mucous lining of the cavity in which it is contained.

Among the rarer pathological phenomena associated with the retention of teeth, or their malposition in the jaw, is the paralysis of certain domains of

the facial area, either in sensation, or motion, or both. This may be occasioned in several ways, but is probably most commonly caused by the extension of the inflammation attending the ulceration of the jaw around retained teeth, to the soft parts about the alveolar process, which may occasionally involve the region of the parotid gland, or the tissues immediately adjacent, thus causing pressure upon the trunk of the facial nerve in that part of its course which lies within the substance of the parotid, or near this gland. It is important to carefully investigate all cases of facial paralysis, in order to ascertain if any affection of the teeth or mouth be the active cause of the disability. This is the more necessary, as the prolonged existence of paralysis is followed by the atrophy of the muscles supplied by the paralyzed nerve, and then the deformity and distortion become permanent.

Thus we find that many conditions of grave character, and serious import to the well-being of the individual, may be associated with the disturbance of the processes attending the second dentition, and that often a permanent deformity, either of the denture or of the features, may result from accidental deviations in the normal development of the permanent teeth. To prevent distortion, no less than to heal diseases, is the province of the medical adviser, in regard to the teeth, as well as in relation to the other structures of the human body. The dentist who neglects either of these functions, fails to perform his duty to his patients.

PART II.

CHAPTER VII.

GENERAL PATHOLOGY OF THE TEETH.

In attempting the special study of dental Pathology, attention is properly first directed to those diseases or abnormal conditions of the general system, which, by their existence or their effects, produce disease of the teeth themselves, or awaken destructive changes in the neighboring organs. The consideration of the relations existing between the various structures contained within the oral cavity, the manner of their arrangement one toward another, the nature of their coincident affections, and the extent to which the organs and parts in the vicinity may become involved in the disturbances of the teeth and their surroundings; and the way in which even remote organs may be affected by diseases of the teeth, must attract the earnest attention of the dental surgeon.

Cases are not infrequently observed in which some disorder of nutrition which may be due to one of many general causes, and which affects the system at large, is also seen to act locally upon the oral structures; and thus by the interference with the functions of the system at large, destructive changes

may be induced in the teeth, or in other organs in the immediate vicinity.

The disease of some important viscus remote from the mouth, may be followed by the appearance of pathological changes in the dental organs, from the lowering of the tone of the system, and the diminution of the general strength; or from other causes.

The dentist is frequently consulted upon pathological conditions in the oral organs which are plainly due to a general disease, and in which the treatment must be directed to the care of the systemic disorder, fully as much as to that of the teeth themselves.

The occurrence of tetanus or lockjaw after surgical injuries comes under this head, as well as many other accidental conditions which are associated with the existence of remote diseases, acting through the nervous system, or producing disturbance of the oral structures by interference with the circulation, or in other ways.

Another marked difference in the character of many of the diseases affecting the teeth is due to the circumstances of age of the patient, the existence of hereditary tendencies, the presence of deformities, or the congenital absence of more or less important parts. The sex of the patient may also have an important bearing upon the origin and course of many diseased conditions of the oral structures, as well as upon the other organs and functions of the body.

The dentist who should fail to recognize the constitutional origin of the dental disease in such cases

as are here alluded to, would overlook the most important feature in determining the treatment of the case.

Certain defects in development, by which some of the parts may become displaced or distorted, are often followed by complicated and distressing disturbances of nutrition, and consequent actual disease of the structures involved.

The direct violence of mechanical injuries by which the continuity of the tissues may be disturbed, or the circulation within the part be modified, or the nervous distribution interrupted or gravely affected, may be followed by serious changes in the structure, or the functional integrity of the jaws and teeth.

Chemical action of various kinds is not infrequently the cause of disorganization, more or less extensive, of the structure of the dental organs. This category includes those substances which act locally, by actual contact with the tissues of the tooth, as well as those which induce a gradual change in the integrity of the dental tissues, as the consequence of other and extensive action in and through the entire system.

The characteristic appearances which are observed in the teeth of the aged, the changes in their anatomical structure, and the senile decadence which they undergo, form the closing paragraph in the general survey of the field of dental Pathology. The deviations in shape, and the changes in structure of the jaws at different periods of life, from the first appearance of the tooth germs to the slender and atrophied lower maxilla of toothless old age, are not here

included, but will be considered at the proper place, as a distinct subject.

The study of the diseases of the teeth themselves should consist in an endeavor to ascertain in what way the structures of the tooth have been affected, *how* its tissues have been changed, its functions perverted, the surrounding tissues affected, or even destroyed. We should consider the various forms of disease of the bones in which the teeth are fixed, the occurrence of exostosis and hyperostosis and other malformations of the dense tissues, the inflammations of the soft parts, and the retrogressive changes, such as senile degeneration and dental atrophy. The affections of the investing mucous membrane of the tooth, as well as those of the pulp-cavity are classified by themselves. Another class of pathological processes is due to the effects of injudicious diet, or insufficient nutrition; and still another group of affections is the result of the direct action of chemical or other irritant or corrosive substances.

The investigation of the cancerous and other malignant growths would form a separate study, inasmuch as the character of the growth is usually in no way different when located in the mouth, from what is observed in other parts of the body. The literature upon the relation of systemic diseases to the lesions of the dental organs is extremely scanty. The most popular and best known text-books hardly allude to the subject. When we consider the importance of this subject, we must feel some degree of surprise that attention has not been more forcibly

directed to the great influence of the general condition of the health upon the state of the growing denture, either in the way of modifying its development, or in inducing more or less serious departures from the normal type of formation; by which either actual disease may be induced, or what is far more likely, a tendency may be implanted in the organism which may lead to the degeneration of the dental organs by increased vulnerability; or by the absence of certain of the normal and necessary structures composing the tooth, and the destruction of the dental organs from inherent defects in their formation.

The influence of proper remedies upon the diseases of the hard tissues, is now one of the recognized facts in the surgery of the body at large. The same is no doubt true in the surgery of the dental organs, but this seems to have been strangely neglected. Why is it not fully as reasonable to hope for a renewed and restored nutrition in caries of the jaw, or in threatened conditions of the teeth, as it is to expect a regeneration of the long bones of the leg, or of the arm, after necrosis of these structures? This is now a recognized occurrence; cases are daily becoming less rare in which the whole of the body of a long bone has been removed, and recovery has followed, with complete restoration of integrity and function of the parts involved. The bony structures have been regenerated, and the powers of the limb have been fully restored.

If these regenerative processes can take place in the long bones of a distant extremity, it would seem certainly probable that similar restorative changes

might occur in a part so highly vascularized and so susceptible to the action of remedial measures, as is the jaw; and if in the jaw, then why not in the teeth? These organs would seem to be peculiarly adapted for the beneficial action of general treatment. They are buried to more than half their volume in a vascular and highly vitalized structure, from which they are supplied with numerous and important channels of nutrient character, which penetrate every portion of their substance; the interior of the organ is provided with a pulp consisting of connective tissue, and containing a large number of nerves and blood-vessels, which ramify through the entire tooth structure, and furnish the means of ample and rapid metamorphosis of tissue. How far the conditions here suggested would prove true in actual practice is not yet settled, but certainly no more fertile field for original investigation could be presented to the careful and observing dentist, than the one here mentioned, and no more useful subject could occupy the leisure of a devoted student than the elucidation of this obscure point in the management of certain forms of disease in the dental organs.

PART III.

CHAPTER VIII.

RELATION OF THE DIGESTIVE ORGANS TO DISEASES OF THE MOUTH AND TEETH.

Of all the causative agents in the production of disease of the dental organs, none are more frequent or more disastrous than those which depend on disturbances of the function of digestion and that of assimilation. These derangements may be of very varying character, and may be located in any portion of the digestive tract. Both sexes are alike subject to these disorders, and no age or condition is free from their pernicious influence. Their operation may at times be noticed in the infant of a few hours, or it may be observed in the aged. Too little attention is directed to this great class of affections as factors in the production of disease of the dental structures, and too often the destruction of the teeth is not recognized until these delicate and necessary organs are lost, or too far decayed to admit of integral or artificial restoration. Few appreciate the importance of the diseases embraced under this head, least of all the patients themselves, who are apt to imagine that, because this class of maladies is rarely of itself directly the cause of death, they are,

therefore, of trifling consequence. It is not to be supposed that a perpetual mal-assimilation, a constant defect of nutrition, can be devoid of detrimental effect upon all the tissues and organs of the body, or upon the proper exercise of their functions.

In children who from any cause are badly or insufficiently nourished, there is always a marked retardation in the development of all the organs. The face wears a pinched and wrinkled appearance, the color of the skin is either a transparent, dead white, or it is tinged to a greater or less degree with yellow. The hair and skin are often noticeably diseased, and the natural orifices of the body are frequently the seat of ulceration, or otherwise diseased. The degree of emaciation which ensues is often astonishing. The bones remain soft and flexible, and should the child be able to stand or walk, the legs often become curved from bending of the long bones; the chest is misshapen from the distortion of the ribs, and the form of the patient is often greatly disfigured. In cases which occur at a time previous to the eruption of the deciduous teeth, their appearance is often delayed, or they erupt very slowly and irregularly. Frequently a year is required for the advent of the central incisors, which normally appear at about the seventh month. The other teeth of the first dentition are correspondingly slow to make their appearance, and occasionally the first dentition is imperfect, from a permanent absence of one or more of the teeth belonging to that set.

A child born with a load of inherited disease, insufficiently nourished both in quality and quan-

tity of food, can hardly be expected to furnish perfect and durable structures in any of the tissues, and perhaps least of all in the hard tissues. When the teeth finally appear, they are often seen to be small, puny organs, imperfect and defective in their structure, and especially in their enamel covering. Such teeth are badly nourished, and, in addition to this, they are continually subjected to the injurious action of the abnormal fluids of a sick and weakened system. They often begin a retrograde metamorphosis before they have reached their ultimate growth or normal proportion. The enamel begins to crumble at the top or upon the sides of the teeth; the sour and acrid secretions of the mouth and the eructations from the stomach attack the imperfect dental substance; it becomes darker in color and offensive in odor, and undergoes a rapid decay which is often entirely free from pain, owing to a progressive atrophy of the nervous structures in the teeth, which has preceded the decay that was advancing from the outside. This condition of the teeth may react upon the system, both from the increased difficulty attending mastication, as well as from the continual presence of a mass of disease in the mouth, and thus still further impair the condition of the patient. Particles of food are retained within the spaces and cavities of the defective teeth, and still further corrode them. The saliva becomes acrid, the breath offensive, and the fetor from the filthy and diseased mouth forms still another hindrance to the vitality of the patient.

If the patient who is the subject of this condition—

usually a child—be well cared for, the strictest attention being given to the removal of the various morbid conditions which exist in such a case, and suitable measures be observed for the restriction of the abnormal conditions of the system at large, the destruction of the primary denture may not only be checked, but, what is of vastly greater importance, the eruption of the permanent teeth may take place at the proper time, and in the natural order. The teeth themselves may prove to be solid and perfect in every particular, and may betray no sign of the previous condition of the system, or of the fate of the first denture; nor manifest any tendency to the diseases of the deciduous organs.

As long as the food of the infant consists solely of mother's milk, there is little danger to be apprehended either to the general health of the child, or to the integrity of the dental structures. This is owing to two principal reasons: First, the number of teeth which make their appearance during the period of milk-feeding are comparatively very few, and, second, the disordered conditions due to imperfect digestion are rare, during the period while the diet of the child is composed strictly of mother's milk. This aliment is naturally better adapted to the requirements of the growing child, than any artificial food could possibly be, and at the same time is more easily borne by the child's stomach than any substitute which could be adopted in its place. One undoubted reason of the greater extent of dental disease among the children of to-day than in those of a generation ago, is the fashion of feeding

them upon some other food than mother's milk;—which is unhappily but too extensively disseminated in our country—thus deranging the vital processes of infantile growth by a wrong system of nourishment, to the permanent detriment of the child's health; and frequently also to the destruction of the deciduous teeth. The dental profession is now in a position to accomplish a great deal of good by impressing upon the public the importance of the natural aliment for the young child, at that time of all others when this is most important, that is, at that time in which the dental alimentary structures are being developed, and when the tissues are most susceptible to any degenerative changes.

The manner in which destructive processes are induced by infantile indigestion, is twofold: First there is a diminution in the quantity of nutritive material obtained by the system for its manifold requirements in building the many varying structures which are constantly being developed, and thus their integrity is continually being undermined by the lack of sustenance for their perfect formation; so that the faulty tissues are always liable to break down easily, and thus by their necrosis and consequent suppuration to add to the already existing trouble. We often meet cases of this character in which there is suppuration of the cervical glands with continuous discharge for months, or where there is an offensive and persistent running from the ears, and frequently there is coincident disease of the mucous membrane of the eyes, or other portions of the delicate superficial or visceral organs of the body.

Often the joints are affected, the limbs are distorted, there is infirmity and often persistent disability, and the patient's whole system is debilitated and rendered vulnerable to the slightest accidental influences, and suffers from the mildest forms of physical exposure. We could hardly expect to find a healthy and vigorous condition of the teeth in a child with such a condition of bodily health as that described. In actual practice the reverse is generally observed. The teeth will be found small, usually either crowded irregularly together, or separated by considerable intervals from each other, perhaps diminished in number, often imperfect in character, sometimes the incisors being misshapen and irregular, or the individual teeth of the denture may be protruded from the jaw at any angle from their proper direction, and thus often cause great distortion of the features, and sometimes actual suffering. The congenital irregularity of the teeth is the occasion of the fancied resemblance of the human denture to that of certain animals, as the cat, dog, etc., and we often hear of this form of defective development in the guise of cat-teeth, dog-teeth, wolf-teeth, etc.

It might be difficult to account for the varying forms of denture observed in children, could we not trace the origin of these appearances to something in the manner of life and condition of health of the patient during the early period of dental development; or, indeed, perhaps before the birth of the child. It is an established fact that the intra-uterine period is often the time when certain faults of con-

struction or location of organs occur, and from which they are perpetuated. Examination of the individual teeth in such cases often reveals fissures of the enamel, due not to decay, but to deficiency in original formation; or actual spaces may exist in which it is almost entirely absent; or we may find a minute orifice upon some portion of the presenting surface of the tooth, which leads to a canal in the tissues of the organ communicating with a congenital cavity in the deeper structures of the tooth; or in rare cases the canal so formed may be continuous with the pulp-cavity, thus forming a fistulous opening to the root of the tooth. It is unnecessary to say that teeth which are the subjects of an organic defect such as is here described, are more than usually subject to degenerative changes, and very early fall a prey to caries; or are extracted at a comparatively early age, on account of the pain engendered in them by the progress of the diseased condition. Relief is not always secured even by extraction of the offending tooth, on account of the liability of the bony tissues around the socket of the diseased tooth to take on morbid action, which sometimes leads to necrosis of the bone and the ulceration of the superficial tissues, with the formation of one or more sinuses extending from the surface of the skin or the mucous membrane to the seat of the disease in the bone, or even to a greater depth than the vicinity of the exposed bone. From the openings thus formed there is a more or less constant discharge of purulent matter, which may persist for months or even years, with the separation and discharge of frag-

ments of dead bone, and sometimes more or less hemorrhage from the deeper parts of the sinus.

This condition may finally terminate by the gradual healing of the sinus, with the formation of a deep cicatrix which unites the external skin to the bone; or it may continue to spread along and within the bone, until a great part of the osseous tissues of the affected side, from the ramus of the jaw to the symphysis, when the lower jaw is the seat of the disease, or an extensive part of the superior maxilla, has become necrotic and has been cast off by suppuration. In these cases the remaining teeth usually become gradually loosened, from the softening of the bony tissue containing them, and either require extraction at the hands of the dentist, or they are extruded from the jaw, owing to the lack of sufficient support from the hard tissues to retain them in their natural position.

When recovery has occurred, if this is possible, the resulting appearance of the jaw is that of a deformed and misshapen feature, and it is usually, or at least often, necessary to provide an artificial denture for that portion of the jaw which was the seat of the diseased action.

The second way in which the disorders of the digestive system may affect the integrity of the teeth, is from the liability which such a condition of the alimentary system induces to the regurgitation of portions of the food from the stomach into the mouth. This is a frequent accompaniment of gastric disturbance, and is a symptom of considerable gravity in such cases. The vomiting usually occurs

at a period some time after the ingestion of the food, and at a time in the process of digestion when the contents of the stomach have undergone an acid fermentation, in which new and unnatural products of acrid character have been formed. The presence of these strongly acid eructations in the mouth and in contact with the teeth, is then a matter of frequent occurrence, which no amount of care can wholly obviate.

The existence of this condition is not confined to infancy, but may occur at any age, and from many causes. Sometimes it consists only in an occasional regurgitation of a small amount of fluid from the stomach, at some period after a meal, and may then be due to the ingestion of some substance of an indigestible character, or to the temporary disturbance of the process of gastric digestion from some other temporary and local cause. Oftener it is, however, the result of long-existing and chronic disturbance of the digestive function, and there is a regular and considerable degree of regurgitation of the contents of the stomach. The vomited matter has a strongly acid reaction, and is frequently of fluid consistency and of mucous character. The normal gastric digestion will be found to have been replaced by an acid fermentation of the food, with the production of lactic and butyric acids. There is a total suspension of the natural process of digestion.

When fluid of this character is violently regurgitated from the stomach into the mouth, the teeth are necessarily bathed in it, and are constantly subjected to any chemical or other action which the presence

of a fluid of this character may excite. It is an established fact that chemical action at once commences between the acid fluid from the stomach, and the tissues of the teeth, which slowly, but none the less surely, erodes the enamel by its solvent action, and finally penetrates this layer of the dental coverings, when it extends its ravages more rapidly into the unprotected tissues beneath. The destructive action of the disordered gastric fluids upon the teeth may advance with such rapidity that a disturbance of the digestive function, of only limited duration, may be followed by the impairment or loss of all or nearly all the denture. This effect may be produced in relation to either the temporary or the permanent structures.

The accumulation of foreign matter of any kind upon or between the teeth, where it may remain for some time without being disturbed, is another source of danger to the teeth in any condition of the system in which there is eructation of acid matter from the stomach.

Particles of food are prone to accumulate around or between the teeth, unless great care is exercised to avoid it, and these collections in obscure parts of the denture are often the starting point of extensive decay. The spaces between the teeth are especially liable to retain masses of foreign material, and are the favorite seat of the destructive processes due to acrid regurgitation from the stomach. Under these circumstances the enamel is observed to become white and lustreless, the texture becomes brittle and friable, the animal matter disappears, and the super-

ficial layers of the tooth structure become changed to a crumbling mass which may be removed by any slight touch. At times the process of destruction is so rapid, and the change in the tissues so extensive, that the tooth breaks squarely off, leaving a rough and ragged fracture, which wounds the lips and tongue, and often causes ulceration of the neighboring parts. The teeth which are the seat of this disease are often exquisitely painful, owing to the fact that the decay of the hard portions of the body of the tooth finally reaches the dental canal. The structures of the pulp then take on inflammatory changes, and the tooth becomes the seat of acute pain which often affects not only the tooth originally diseased, but extends to neighboring sound teeth.

CHAPTER IX.

BACTERIA AND THEIR ACTION IN DISORDERS OF THE TEETH.

In this connection may properly be mentioned that class of diseases of the teeth which is supposed to be due to the presence and action of the various animal and vegetable parasites, principally the latter. Certain forms of low organic life of parasitic character are uniformly found in the mouth, even in a state of health, and are not excluded by any degree of care of the teeth; but these natural and constant forms are not thought to be the cause of disease of the oral organs under ordinary conditions. When fermentative changes are going on in the stomach, however, we find that new forms of bacterial organisms at once appear in the mouth, as the companion of the disordered digestion, and these new forms of bacteria are associated with the putrefactive and fermentative character of the processes going on in the stomach. They are supposed to be principally of vegetable nature, and are the regular and associated accompaniments of fermentative decomposition. They are invariably found in the mouth when this condition exists in the stomach, that is, of course, if regurgitation of the fermented matters takes place into the mouth. These minute organisms are thought by many observers to be the cause and origin of the carious degeneration of the teeth in cases such as

have been described above. They are believed to propagate rapidly in the interstices between neighboring teeth, and by their increased numbers to invade the minute canals of the teeth,—the dental canaliculi,—entering from the surface of the tooth with which they lie in contact, or from the cavity in which they may have become lodged, and where they have remained undisturbed for a longer or a shorter period. While it is an undisputed fact that various parasitic growths are often, indeed, almost always, found in association with advancing caries, it is still an open question whether caries is necessarily, or in any way frequently, the direct result of bacterial invasion, or connected with the presence of any of the common forms of the lower organisms.

Authorities are not wanting who enumerate and describe the parasitic diseases of the mouth with a degree of assurance and positiveness not warranted by our present knowledge upon this subject. The recent increased importance ascribed to the various forms of bacterial growth in the production of many of the diseases of the body at large, has made us acquainted with many facts in relation to these bodies which were not before known, and this should make us more than ever circumspect in our assertions in regard to the degree of importance to be ascribed to them in the production of disorders of the nutrition, or in the degenerations of the dental tissues. Certain of the bacterial forms are constantly to be found in every mouth, and are not known to do the slightest harm. Thus, a careful microscopic examination of the interior of almost any mouth

will disclose the presence of a certain parasite, called the "leptothrix buccalis," in some stage of its development. It is found in health as well as in disease, it is found in clean mouths as well as in those which are filthy, it is not fastidious as to the color, sex or condition of its host. Climate and temperature seem to have little effect upon it, for the conditions of heat and moisture within the mouth are much the same whatever may be the state of the outside climatic influences. This organism is a constant inhabitant of almost every mouth. After the most scrupulous cleansing of the teeth at night it may be found in great numbers in the morning; it will develop under almost any circumstances, and in almost any conditions; it will bear any temperature with impunity which can be applied to the mouth without injuring the mucous membrane, and it will withstand any ordinary chemical insult. Under the circumstances above mentioned it would indeed appear strange if this parasite should not be found upon and around all the parts of the mouth in disease. It is of very small size, and its spores are much more minute than the mature organism, and have the power of attaching themselves to almost any surface or substance with which they come in contact. What wonder, then, if we discover them upon the outside of the teeth, in the mass of detritus found between neighboring teeth, or even in the filthy and decomposing substances which are often observed in connection with dental cavities. All this in no way, however, proves that these minute and feeble organisms (or germs) are capable of disintegrating and destroying by their

unaided activity the most dense and compact, as well as the most resistant tissue of the human body. That their presence may accelerate the decay of the dental structures, and in this way be harmful, is not to be denied, but their importance in this direction has undoubtedly been greatly over-estimated.

There is another form of bacterium which is sometimes found in the mouth and about the teeth in some forms of disease of these structures. This organism is far better known than the Leptothrix, and, unlike it, may be found in all parts of the body wherever the conditions are favorable for its development. It is always associated with the process of decomposition, and is regarded as indicative of that condition. It is observed in the form of small, moderately thick staves, which may be attached to one another to make small chains, but more generally are found singly in the field of the microscope. They are thought to be also of vegetable origin, and are supposed to act as scavengers, by consuming the products of decomposition, or by destroying the virulency of these products by a process of oxidation, thus changing their chemical composition. Their vital activity is thought to diminish the injurious nature of the decomposing substances in which they are found, and, finally, to render such matter harmless. The presence of this organism is looked upon as indicative of decomposition, and the detection of the bacterium in the wounds of general surgery is always a reason for the most scrupulous and unremitting attention to the patient. In dental surgery the presence of this parasite in wounds has

the same meaning as in the surgery of other parts of the body. If found in a mass of débris lying between the teeth, it is an evidence of the putrid condition of the matter concealed there, which, of itself may inaugurate disease in or about the teeth. When they are found in the teeth as a part of the contents of a foul cavity, they prove only the filthy condition of the diseased spot; that is, they indicate not only that disease already exists in the place where they are found, but that chemical decomposition of the products of disease, or of the surroundings, is there going on, thus establishing the most unfavorable conditions possible in proximity to a diseased part. It is proved that bacteria may penetrate into any channels which open upon the surface where they are situated. They are often found at some distance from their original seat. Whether this migration is accomplished by voluntary effort, or by the unconscious and organic movements of the parasite, is not definitely established, but the fact remains that they possess the power of locomotion. Another way in which they may change their location is by the current of blood or lymph, or by the movements of any other tissues of the body into which they may have penetrated. The moving tissues of the animal body convey the bacteria from one point to another in a purely mechanical manner. This occurs far more frequently after injuries or operations upon the body at large than in the tissues of the mouth, but no doubt it is often an active factor in the spread or direction of certain of the diseases of the mouth which are accompanied by suppuration,

and more especially those of phagedenic character. Such disorders are at times observed to rapidly extend from one structure to another, so that the entire denture of one jaw may fall a prey to a disease which is propagated from one portion of the jaw to another by direct extension, until the entire alveolar structures are affected. In the various forms of necrosis of the jaw, it is quite the rule to find bacteria in the pus and other products of the diseased process, and to find them in all parts where suppuration has occurred, and for a period as long as pus is discharged from the diseased surfaces. No one, however, supposes that the necrosis is the result of the presence of bacteria, or is due in any way to their action, or that the disease is prolonged by their presence. They are regarded simply as an accompaniment of a grave disease, and with the healing of the disease these parasitic organisms disappear; to return only when conditions favorable for their development have again been established.

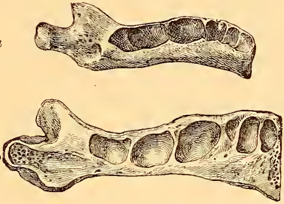
CHAPTER X.

DEFECTIVE EMBRYONIC DEVELOPMENT OF THE MAXILLARY STRUCTURES.

The early history of the dental structures is shrouded in uncertainty. The study of the development of the individual organs is attended by difficulties such as are not associated with the histological investigation of any other of the structures of the human body. The maxillary bones are among the earliest formations noticeable in the embryo, and the lower jaw is the first osseous tissue developed in the body. There can be but little doubt that the views prevailing among anatomists at present are in the main correct, and they certainly explain the relations and connections of the oral structures better than any others at present extant. The accepted opinions at the present time are something as follows: During the earliest stages of intra-uterine life, which naturally is the only period at which analytical research could offer any prospect of reward, the tissues of the embryo are but partially formed, and in a state of imperfect construction. The rudiment of the superior maxillary bone is observed at a date about the third week from conception. This primary structure is formed by the union of two of the early lateral projections of the embryonic body, called the thoracic arches, which are thrown out after the union of the germinal membranes. The superior arches are earlier

developed and join each other earlier than the inferior ones, and, consequently, the primitive superior maxillary is earlier in point of development than the inferior. The histological character of this early formation is very simple. It consists only of simple rounded or oblong cells, the so-called "embryonic connective tissue," and presents the greatest similarity to the *granulation tissue* found in the process of repair

Fig. 11.



(*a*) Macerated left half of the inferior maxillary arch, from a fœtus, at the seventh month of pregnancy. View from the lingual side. The partitions or septa for the incisors are partially formed; the facial wall of the canine tooth still presents a gap. The septa for the milk molars are indicated by slight ridges; that for the first permanent molar is already perceptible toward the coronoid process. Natural size. (*b*) Left half of the inferior maxillary arch, from a new-born child; decalcified by means of dilute hydrochloric acid, and bisected by an incision corresponding with its curve. The incised surface of the outer half is exposed to view; the dental sac and contents are removed. The separate walls for the dental sacs of the milk teeth are completely developed; the septum for the first permanent molar is seen to be partially developed within the coronoid process. Natural size.

of wounds in adult life. As yet no blood vessels or nerves are observed in the part; the growth of the organ takes place simply by means of active proliferation of the round cells above mentioned, in the arches and in their vicinity. The inferior maxilla is somewhat later in its development from the two primary arches than is the superior, but after its

fusion it advances more rapidly than the upper, so that at length it is the first bone in the animal body to undergo the process of ossification. At the time of birth the lower jaw is deemed the strongest bone in the body, and in some cases of difficult labor, in which the operation of version becomes necessary, the birth of the head of the infant becomes a matter of great importance, and, indeed, is sometimes almost impossible. In such cases, the most favorable point for manual traction is the arch of the lower jaw at the point of union of the two lateral halves. At this point, the most forcible tractile power which can be safely applied may be exercised without the production of injury either to the jaw or to the child In many cases of this kind, in which the child is known to be dead, violent traction has often been steadily exerted at this point through a considerable time, and it is rarely the case that the jaw is fractured or otherwise injured. When we remember how frequently and how easily the other bony structures are injured during birth, it may well seem that the maxillary bones are endowed with an unusual degree of resistance at this early period.

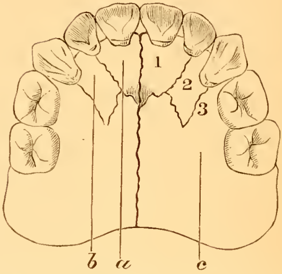
The exact period at which ossification of the maxillary bones takes place is not certainly known, but a true bony structure is observed soon after the junction of the two lateral halves of the jaw, and in the upper jaw this seems to proceed from four centres on each side, each centre of ossification spreading until it joins the other osseous masses, except in the case of the centres of ossification for the intermaxillary bone on each side containing the incisor teeth, which

is joined to the rest of the bone by a well-defined suture on either side. The early formation and solidification of this bone is one of the chief factors in the formation of the face; the general outline of the features and the expression of the countenance depending more upon the shape and relations of the superior maxilla than upon any other bony tissue of the body. The malar bone, although a separate anatomical structure, may, in its relations to the formation and contour of the facial region, well be regarded in this connection as a part of the superior maxillary, as it corresponds closely to it in its time and manner of development. The absence or deformity of either of these bones causes great disfigurement and lasting deformity. At times, the process of ossification is retarded in some portion of this bone, particularly in the vicinity of the sutures between the various parts from which the superior maxillary is formed, so that a close approximation of the neighboring bones cannot occur, thus leaving a fissure between them of greater or less extent, which is recognized as the well-known condition of *cleft*, either of the soft palate alone; or, quite as frequently, it extends through a portion or the whole of the hard palate, often dividing the lip and extending into one or the other nostril, which is thus continuous with the oral cavity. When this is confined to the median suture, it presents a fissure running from behind to a greater or less distance forward toward the incisor teeth, in the place of the velum palati and of the suture naturally found in this location. Sometimes the fissure is quite limited in extent, and consists

Fig. 12.

Cuts Illustrating the Formation of Cleft-Palate.—*After Prof. Albrecht.*

1



(1) The superior maxillary body is formed by the union of the two superior maxillary bones and the intermaxillary bone. In its original development the intermaxillary bone is composed of four smaller bones, arising from four separate centres of ossification, and united to each other and to the body of the superior maxillary bones on each side by sutures. The bones and sutures have received the following names:—

a, Internal intermaxillary—Endognathion, *b*, external intermaxillary—Mesognathion; *c*, superior maxillary bone—Exognathion. 1, Inter-endognathic suture; 2, Endo-mesognathic suture; 3, Meso-exognathic suture.

2

(2) The location of the teeth in the ordinary superior primary denture of the human mouth. The internal incisor is contained in the internal intermaxillary bone (endognathion). The external incisor (precanine) is contained in the external intermaxillary (mesognathion).

3

(3) The location of the incisor teeth in cleft-palate with three incisors on each side the median line. (Specimen in the collection of the Anatomo-Pathological Society of Brussels.) The internal intermaxillary bone (endognathion) contains two incisor teeth on each side the median line, the third incisor being contained in the external intermaxillary bone (mesognathion).

only of a notch in the soft palate, which may be quite symmetrical, or may be more pronounced on one or the other side, with a more or less well-developed uvula depending from the other. In other cases the gap is very extensive, the roof of the mouth presenting a yawning chasm, through which the turbinated bones may be seen, if they be in their proper location; the vomer, and in some cases even the ethmoid and the base of the skull, may thus become visible. In extreme cases there is often, if, indeed, not generally, a corresponding lack of union at the seat of the suture existing between the two maxillary bones and that portion of the upper jaw which

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In the cleft-palate with *four* incisors, the internal intermaxillary (endognathion), contains only one incisor tooth, while in the case of cleft-palate with *six* incisor teeth, the internal intermaxillary contains two incisor teeth. It becomes evident on reflection that the incisor tooth situated nearest to the median line, that is, the internal of the two incisors contained in the internal intermaxillary, is the homologue of the single tooth contained in the internal intermaxillary bone in cleft-palate with four incisor teeth. The tooth situated nearest to the symphysis between the two internal portions of the intermaxillary bones, the median suture, is called by Prof. Albrecht the *parasymphysienne* incisor tooth. The two parasymphysienne teeth contained in the cleft with four incisors are therefore homologues of the teeth contained in the normal milk denture The additional tooth contained in the internal maxillary bone, in cleft with six incisor teeth, and which is called the *proparasymphysienne* incisor, has no homologue in the ordinary human milk denture of cleft with four incisors. In the ordinary cleft with four incisors, the parasymphysienne incisor is the *first* incisor tooth. The precanine is the second incisor. In cleft with *six* incisors the parasymphysienne is the *first* incisor; the precanine is the *third* incisor. The superior internal incisor, or the parasymphysienne, is in reality the *first* incisor. The external superior incisor tooth, or the second incisor, of the normal denture, the superior precanine, is in reality the *third incisor tooth*. The real second superior incisor is no longer developed in the ordinary human denture, but in cases of cleft with six incisors this tooth reappears, and constitutes the second incisor of these cases. This reappearance is due to atavism, which is observed in many other respects in relation to the human body under certain conditions. In the cases of cleft with six teeth, the internal intermaxillary bone, the endognathion, carries the additional tooth, and the third, the precanine, is contained in the external intermaxillary bone (mesognathion).

contains the incisor teeth, the primary intermaxillary bones, by which the front of the cleft is divided into two distinct fissures, like the two arms of a "Y," and the intermaxillary bone is then entirely free from any bony attachment to the rest of the maxillary structures. In this extreme condition of deformity, the fragment of bone with the incisor teeth is often twisted into an abnormal shape, and is generally crowded forward so that it protrudes beneath the nose, producing a degree of disfigurement truly frightful to behold. The palatine surface of the small intermaxillary bone is sometimes turned directly outward, so that the contained teeth are projected forward and are at all times exposed to view, the patient not being able to cover them with the fragment of upper lip, which is all that usually exists in such cases, or, at least, the upper lip is relatively very much smaller than normal, and quite insufficient for protection of the misplaced teeth.

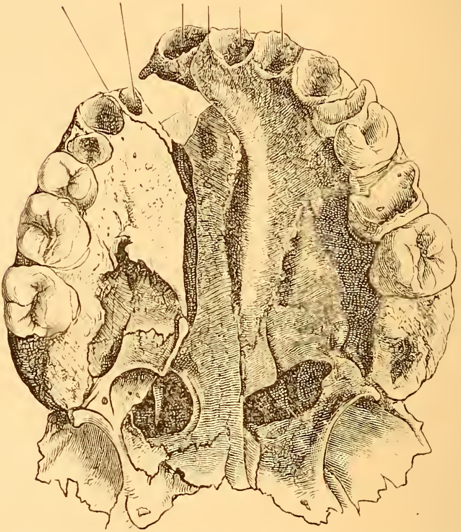
In most if not in all these extreme cases there is a corresponding defect in the formation of the upper lip, so that a fissure is observed in the lip, which communicates with the nostril of one or the other side. This defect of the soft tissues then leaves the mouth always more or less open; it is impossible for the patient to close the mouth against the ingress of air, or to retain fluids in that cavity. The same fissure also extends into the nose, as above stated, and thus the nostril of the affected side is continuous with the cavity of the mouth, from which it is impossible for the patient to separate it, as is ordinarily done in speaking or swallowing. The speech is

seriously affected by the absence of a partition between the mouth and the nose, and the person so affected has a peculiar and characteristic articulation, commonly described as "talking through the nose," which is caused by the patient's inability to shut off the nasal cavity from that of the mouth. Occasionally there are other defects of formation in the patient with cleft palate, due to the same general cause, that is, a lack of complete union of the lateral portions of the body in the median line. These defects are frequently situated in parts of the body not usually exposed to view, and often are of extensive character, and at times seriously interfere with the natural functions of the body. They are also occasionally of such a degree of gravity in their influence upon the organism, that attempts are made to remedy them by surgical measures. Upon the back, a deficiency is sometimes observed in the spinous processes and in the lateral masses of certain of the vertebræ, producing the condition called "spina bifida," and is due to a lack of junction of the dorsal plates during intra-uterine existence. This condition is observed only during the earliest period of existence after birth, for it is very rarely the case that the infant so affected survives more than a day or two, and frequently expires immediately. Other serious malformations or entire defects of important internal organs or parts may exist, which render it impossible for the processes of life to be sustained in so imperfect an organism. Cases of this character are fortunately not common, and when observed they represent the extreme degrees

of lack of union of the visceral plates during embryonic life.

From the preceding it will be seen that in many

FIG. 13.



Palatine view of the skeleton of the superior maxillary body of a man, showing complete unilateral cleft of the right side. The plate shows indications of the sutures between the primary elements of the intermaxillary bone, and the alveolar process is divided at the seat of the meso-endognathic suture on the right side.—*After Prof. Albrecht.*

of the cases of deficiency or of abnormal arrangement of the dental organs, this is not wholly a local process, confined to one special portion of the

animal organism, but that it is related to a defect in the constructive force of the entire body, and may find expression in other parts of the human frame as well as in the mouth and face.

A careful study of the exact extent and of the relations of the deviations of the animal body will often discover deformities of one or another part due to deficient constructive force, by which the various tissues and organs are imperfectly formed or are insufficiently maintained; the result of which is a greater or less disturbance in the normal functions of the parts affected, or of the entire organism. In cases in which a lesion of this character is detected in the mouth, an effort should be made to ascertain if this is the only defect of development, or if there be not other conditions of imperfect construction of the organs in other parts of the frame. A separate notebook devoted to the observation and record of deformities, with drawings and descriptions of the same, and accompanied by as much information concerning the appearances and habits of the individual as can be obtained, would form a valuable contribution to the study of the great and interesting subject of the congenital or, more properly speaking, the embryonic defects of the animal body. We shall revert to this subject again at more length in that part of our study in which we take up those diseases associated with the malformations of the oral apparatus.

CHAPTER XI.

DEFECTIVE DEVELOPMENT CONTINUED.

Defects of formation are not so frequently observed in the lower jaw as in the upper, and are usually limited to more narrow deviations from the normal. One of the more common varieties of malformation in this part of the oral apparatus consists in a condition observed in certain cases, in which the jaw is complete in shape and perfect in form, but is diminutive in size in relation to the other organs of the body. Occasionally, a variation in the arrangement of the teeth occurs, which may be due to some abnormal condition affecting the dental germs, and not the tissues of the jaw itself. Of these we shall speak in another place. The most striking anomaly in relation to the lower jaw is that which is sometimes observed in so-called "strumous" children, and which consists in the persistence of an infantile condition of the inferior maxilla in adult life. At the time of birth, the jaw is normally developed, and corresponds with the coincident development of the other bodily organs, but while the other structures of the infant's body increase in size and strength, the tissues of the jaw do not grow after this period, but preserve their puny condition. For some reason not at present known, the formative energy in this bone seems to be confined to the simple reproduction of the previously existing structure,

while the organic impulse toward a natural increase in volume and power, proportionate to the rest of the body seems to have been wholly obliterated. The most marked case of this condition which has thus far fallen under the observation of the writer is that of a young man seen some years ago. The patient comes from a strong and vigorous family, is one of several children, some of whom are younger than himself. He considers himself perfectly well in all the ordinary acceptance of that term, does a thriving business in a small way, and apparently enjoys life quite as much as most people. He was 22 years of age at the time these notes were made, and was rather short in stature, very slight in build; the limbs and extremities are small, the head in general of relatively normal size for his bodily development. The eyes are bright, the temperament lively and cheerful, and the general condition of the patient is one of comfort and happiness. The upper jaw is of normal size. The teeth have to some extent been removed by extraction, and are inclined to carious degeneration, so far as they are retained in the mouth. Several of the remaining teeth of the upper jaw are neatly filled with gold. They are smaller than usual, and somewhat deformed and irregular. The alveolar process and gum seem to be in a fairly normal condition. The chin and lower lip recede very markedly from the position usually occupied by these parts, and lie in such a plane that a line extending from the cutting edges of the incisors to the hyoid bone would present very nearly the outline of the lower lip and the chin. The appearance of the

face is as if a clean slice had been removed, commencing at the level of the upper lip, and reaching to the hyoid bone, taking the soft parts and the bones, teeth and glands, and all other structures smoothly and evenly to the line of the cut surface above described. The skin is smooth and presents no cicatrix or deformity. There was hardly any power of opening the mouth or of closing it, and the speech was seriously interfered with, the pronunciation was very defective, from the inability to properly manipulate the organs of articulation within the mouth, and the hindrance in the resonance of the vocal sounds. The tongue could be protruded only partially, owing to the small size of the oral aperture.

The tongue was small, but otherwise healthy, the glandular and nervous apparatus accorded to this organ appeared to be in normal condition, the sense of taste was as well developed as is the case in healthy individuals. The lower lip cannot be depressed by voluntary effort of the patient, the lower jaw cannot be seen unless the finger is employed to depress the lip. The lower teeth are small, misplaced and misshapen, some have been extracted to enlarge the opening into the mouth, and those which remain are in a line nearly transverse to the direction of the tongue, that is, nearly in a direction from one glenoid cavity to the other. That part of the lower jaw embraced between the condyle and the angle on each side seems to have grown somewhat since birth, but the part between the two rami seems to have remained in the same condition, as far as

length is concerned, as it possessed at birth, though it is probably somewhat thicker, and has undergone ossification, so as to support the teeth which have been from time to time erupted from it. The finger introduced into the mouth feels the diminutive jaw-bone extending directly across the floor of the mouth, slightly depressed in its central part, an effect no doubt produced by the continuous depressing action of the tongue. The jaw and its remaining teeth have the tendency to shut up within the outline of the upper jaw, and this would really take place except for the volume of the tongue and the bulk of the muscles on either side.

The retreating position of the lower jaw with the soft parts, causes the alveolar process of the superior maxillary bone, with the incisors and canine teeth of both sides, to appear very prominent. They are without any protection in front and below, so that they are uncovered and exposed to sight all the time. Mastication is impossible, and the patient is obliged to live entirely on soft foods, which are sucked into the mouth through the half-opened jaws, and swallowed. Drinking is a serious operation for this young man, and it is needless to say that he is unquestionably temperate in this direction. The body generally is tolerably well nourished, and the patient thinks himself as well as young men in general, though he admits that he "always takes good care of himself." The study of the relation of the deformity in this case to the development of the higher instincts is both interesting and instructive. This patient, though arrived at man's estate, is decidedly

youthful, not to say childish, in respect to the existence of the powers and capacities of manhood. The voice is high in pitch, as before puberty, the tone is sharp and shrill. There is no sign of whiskers or mustache upon the face, there is no hair in the axillary region. The pubes are free from hair and soft. The appearance of the genital apparatus is that of complete apathy. The penis is small, the testicles almost rudimentary. He finds in the society of the opposite sex only that pleasure which a child knows, and is not inclined to cultivate female acquaintance. The whole picture of his demeanor and manners is that of the most simple and unguiled innocence, and it is quite probable that this remarkable individual will run the gauntlet of temptation in this sinful world and take no defilement.

That the absence of the higher organic and moral instincts in this case is associated with the immature or unripe condition in which the whole system has remained, seems to me to be a settled fact, and is made further interesting as a confirmation of the observation of Charles Darwin, that in any species, a weak or imperfect member, or in a cross between two species, the mongrel offspring is either too feeble to arrive at maturity, or if it should survive to reach adult age, it is not gifted with an exalted degree of reproductive instinct, and thus is less liable to prolong its degenerated race than the healthy members are, so that the tendency is toward the extinction of the weak and frail in all classes of the lower ani-

mals. This natural process of weeding out the poor and unprofitable members of any tribe of creatures is the foundation stone of the great theory of "natural selection" and of the "survival of the fittest." In the human race, however, unfortunately this rule of limitation of vigor does not hold good to any such degree as in the members of the lower tribes.

CHAPTER XII.

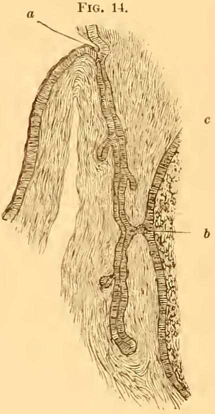
HISTOLOGICAL DEVELOPMENT OF THE TEETH.

The development of the teeth both in the human subject, as well as in the lower animals, has been the subject of much patient study on the part of good observers during many years, and each succeeding year records new discoveries and fresh triumphs in this obscure domain of histological investigation. The conclusions to which the researches of different savants have led, are still vague and uncertain, and often their deductions are doubtless erroneous and misleading. The generally received opinion is, that at a period about six weeks after conception has taken place, the alveolar arch and the surrounding parts have been to some extent moulded and shaped by the junction of the primitive embryonic arches, and are clothed by a delicate membranous covering which occupies the place of the mucous membrane in the fully developed body. At first, this delicate covering is quite smooth and is evenly rounded, giving no indications of any further changes in its shape or relations, but gradually a minute depression or groove appears in its surface, which becomes more strongly marked, first, in the molar region of the upper jaw, and at a little later period in the lower jaw. In the bottom of this groove may soon be observed certain small elevations corresponding in number and arrangement to the deciduous teeth.

These are the first traces of dental organs, and are the rudimentary tooth germs. They are for a time simple papillæ, but soon the membrane about them begins to grow upward, and at the same time toward the papillæ, so that the tooth germ is gradually buried under the encroachment of the membrane about it, and, finally, it is no more upon the surface of the membrane, but is enclosed in its substance. The tooth was then supposed to be gradually developed in some unknown manner from this buried papilla, and finally to be protruded from the gum at a period from four to eight months after birth. The recent studies of men like Waldener, His, and Koelliker have thrown much light upon the hidden processes of the formative period of the teeth, and explain in a more satisfactory way, because in a more reasonable way, the structural development of these parts. I will here take the opportunity to say, that much of the ground in this domain of histological study has recently been most carefully and thoroughly gone over by Prof. Andrews, of this College, than whom I do not know a more conscientious and diligent observer, and his conclusions in all essential points confirm those of the authorities I have mentioned above. Prof. Andrews' enthusiasm for his profession, his experience in the use of the microscope, and his carefully trained eye in minute distinctions of color and form render his deductions in embryological histology of exceptional worth, and have added much to the value of the facts already composing our fund of positive information by lending assurance of their correctness.

Starting from the period when the embryonic arches have approached each other and have united upon the medial line to form the primary maxillary structure, and the development upon its surface of the smooth membranous expansion, later researches

FIG. 14.



A FOLLICLE OF MUCOUS CELLS EXTENDING FROM THE DENTAL RIDGE TO THE ENAMEL GERMS OF THE MILK AND PERMANENT TEETH; FROM A HUMAN EMBRYO OF THREE MONTHS' GROWTH.

The cells of the mucous layer of epithelium dip down into the substance from the dental groove (*a*) of an incisor of the lower jaw, and resemble, somewhat, a tubular gland with lateral offshoots At about the middle of the follicle, which is lined throughout with cylindrical cells, it is connected by a transverse process (*b*) with the external epithelium of the enamel organ, the spongy layer of which is represented (*c*). The inferior closed portion of the follicle is the enamel germ of the permanent incisor tooth. Magnified 80 diameters.

show that the first indication of a tooth germ consists in a slight groove upon the surface of the membrane in the alveolar line, somewhat as before described. The subsequent processes, however, are

entirely different from the course described by Goodsir, in the works usually consulted upon this point.

At the period of the development of the tooth germs a papillary prolongation of the mucous layer is seen, which soon becomes much enlarged, so as to dip deeply into the submucosa, which consists at this time here simply of round-celled granulation tissue; such as is the medium of new formation and repair, in the healing of open wounds in the adult body. The papilla is connected by a narrow neck with the surface of the membrane, but its

Fig. 15.

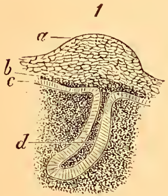
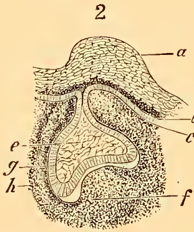


Fig. 16.

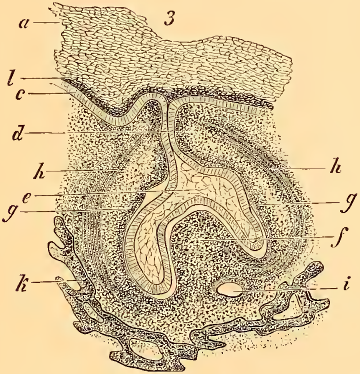


deeper extremity rapidly increases into a club-shaped mass of relatively dense tissue; and soon there can be distinguished three distinct elements in its structure. It becomes continuous from the molar region on one side to that of the other, curving somewhat toward the oral cavity at its free edge. This now is called the enamel germ (the club-shaped prolongation into the tissues of the alveolar mass), and seems to be not like the connective tissue, but resembles epithelium, which has undergone a peculiar trans-

formation in structure and in appearance. The Enamel Germ is absolutely the earliest discernible rudiment of the dental structures and is not to be confounded with the Enamel Organ to be spoken of further on. Indeed, some observers claim to have observed it as a prolongation into the substance of the rudimentary jaw at a period when the two lateral portions of the jaw were not yet united, and it is certain that this feature of development may be easily demonstrated long before the appearance of anything like a papilla upon the dental ridge in the dental groove. At this time there is no indication of alveolar ridges. A little later we find papillary formation on the lower side of the epithelial body, which soon begins to press upon the lower surface of the enamel germ, and at the same time important changes are already going on within this body. The epithelium in its interior becomes gradually changed into a softer, colloid-like substance, the layer next the wall becomes columnar, and both begin to change their location nearer to the surface of the mucous membrane before the advancing tooth papilla. The enamel germ has now materially changed its character, and has become an organized viscus, and it is hereafter called the Enamel Organ. Beneath this is formed at this period a small elevation of the embryonic tissue, somewhat more dense than that in its neighborhood, which raises up the lower surface of the enamel organ like indenting a rubber ball by means of pressure upon one of its sides. This is the true Tooth Germ, or Zahn-papilla, and from it is to be constructed, in the further development of this

organ, the dentine, the pulp with its vessels and nerves, the cement and the peridental membrane. The enamel organ is at this time the more advanced in its structure, and seems to consist of a closed sack lined with columnar cells, containing in its cavity a mass of softened and plastic material from which the enamel is later elaborated in some way not at present understood, which is then deposited upon the

FIG. 17.



apex of the tooth papilla like a thin, glistening flake, which gradually covers its whole surface. The growth of the pulp slowly presses the enamel organ more and more together, thus tending to obliterate its cavity, and in this way forming a conical covering for the papilla which finally extends over its superior surface, and is called the Dental Cap, or the

Enamel Cap. When the enamel organ is thus far formed a small diverticulum is observed upon the median side of each tooth germ, which becomes gradually removed from the tooth germ into the sur-

FIG. 18.

SAGITTAL SECTION OF A LOWER JAW FROM THE EMBRYO OF A DOG, SHOWING AN INCISOR WITHIN ITS DENTAL SAC.

(*a*) Facial lip of the dental ridge; (*b*) epithelium; (*c*) corium, with papillæ in the dental ridge, and cavities of transversely divided vessels; (*d*) enamel germ of the permanent incisor containing an aggregation of epithelial cells; its connection with the enamel organ of the deciduous tooth does not appear in the section; (*e*) anterior, (*e′*) posterior, osseous lamella of the jaw with rounded summits; (*f*) completed enamel of the dental cap; in the section it is separated, somewhat, from the (*g*) layer of enamel cells; (*h*) retiform connective tissue of the dental sac; (*i*) outer epithelium of the enamel organ completely investing the papillæ of the dental sac; (*k*) spongy layer of the enamel organ; (*l*) completed dentine of the cap; (*m*) layer of dentinal cells; (*n*) dental pulp with wide vessels in its interior. Magnified 20 diameters.

rounding tissues, and is finally entirely separated from this organ and is found as a simple independent collection of the same cellular material in a space by itself. This is the rudiment of the Enamel Germ of the permanent tooth, which is an offshoot from the enamel organ of the deciduous teeth. The germ remains dormant for a time, where it has been deposited, and finally is developed into the structures of the permanent tooth in a manner similar to that in which the milk tooth was formed. The further progress of the tooth germ, its development into the form it is later to assume, its elevation toward the mucous membrane, and finally its eruption from the jaw will be familiar to all, from proper collateral studies, and it is not necessary that we should follow the subject into its minuter details here.

In the development of the teeth a very interesting feature to the student of comparative embryology is their similarity of origin and development with that of certain other structures, particularly the sebaceous glands and the hair follicles. Indeed, the epithelium of the embryo is one of the most highly dignified structures in its entire organization. Besides glands, hair and teeth, the whole of the brain and spinal cord is formed directly from the external covering of the embryo. The similarity of the germinal tissue from which these organs are constructed and the dissimilarity of the finished organs is also worthy of especial notice.

PART IV.

CHAPTER XIII.

PATHOLOGICAL CONDITIONS ASSOCIATED WITH THE SECOND DENTITION.

Among the causes of the various pathological conditions connected with the teeth at the most diverse periods of life are many which are related to that period which immediately precedes and accompanies the processes attending the second dentition. The process of development and eruption of the second teeth is a perfectly normal one, but, like many other of the natural processes of the organism, it is frequently subject to deviation from the normal course of events by which many unexpected and startling results are often induced. It is well known that the first teeth are developed from the primary dental germs, which at the time of the formation of the deciduous teeth give off a series of diverticula, the germs of the permanent teeth. At the time of the development of the second teeth, the alveolar ridges are occupied by the bodies of the primary or deciduous teeth, their roots extending more or less deeply into the substance of the bone. The permanent teeth assume the form they are ultimately to possess by means of growth toward the external surface, the

tooth being pushed, as it were, from behind toward the mucous membrane by the continuous growth of the radical extremity from the tooth germ at first, and, later, from the peridental structures. For a short distance there is no unusual impediment to the growth of the tooth in its way to the surface, but soon it must inevitably be opposed in this direction by the body or root of the tooth already formed, which occupies the place toward which it is advancing. Now and here commences one of the most interesting as well as one of the most inexplicable processes of the whole life of the individual. As the crown of the permanent tooth advances toward the surface of the alveolus, the tooth which is in front of it undergoes a process of gradual absorption, commencing at the extremity of the root and progressing slowly toward the crown. The loss of substance by the deciduous tooth is not accompanied by the symptoms of caries, for there is no disease of the body of the organ. The individual suffers no pain, nor is there any evidence of inflammatory action about the shaft or the root of the tooth. The body of the tooth simply disappears from the apex of the root toward the free end, until there may remain only that portion of the organ which is above the gum, to which it is attached only by the ring of mucous membrane clinging to the sides of the tooth. If such a tooth be extracted at this time, it may be found with only a fraction of its natural root, or the root may be entirely absorbed and the body of the tooth be absolutely wanting below the level of the alveolar surface.

It is not definitely known how this remarkable

change takes place, nor how or by what means it is accomplished. These are questions yet unanswered, and may well be classed among the difficult problems of our science. The published descriptions of this process are still variously unreasonable and illogical, and some careful student might well make this part of dental histology the subject of special studies. Some of our best text-books assert that there is a new formation of bone in the neighborhood of the absorbing tissues, which new bone is itself immediately absorbed in its turn. This is so unusual a course in any of the processes of the human body, in the fulfillment of the natural phenomena of development, that it may well be doubted if it is ever strictly true; or, should it really exist, it may be looked upon as pathological in its nature. Much has been said concerning the so-called "absorbent organ of the primary teeth." It is described as consisting of round cells much like those of granulation tissue.* The tissue is probably made up of granulation tissue and of nothing else, and it may occur here in one or both of two forms: First, as the material out of which the new structures are being formed, as is the case in the early embryonic tissues, a remnant of which is preserved as the germ of the permanent tooth, as already described; or, second, as the result of the normal irritation preceding and accompanying the second dentition. This is a fact which, so far as I know, has been universally over-

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* See an interesting contribution upon this point by Prof. Frank Abbott, New York.

looked, and the views here presented would seem to perfectly account for the phenomena so frequently described in long and perplexing detail by other and vague methods. Many of the symptoms commonly connected with the processes of the second dentition are those occasioned by any serious disturbance of the general system, and may be produced by many other causes than by the eruption of the teeth. The peculiar irritation attending the development and eruption of the second dentition has, doubtless, a causative effect in the production of this condition at this time; but it is quite secondary in character, and would be induced equally by any other serious change which might be going on in the youthful body. Should the idea here expressed appear improbable, or be considered unlikely to exist in a natural process, the question may very properly be asked: Why not some disturbance in the processes of dentition, as well as in those of pregnancy, which is equally a natural process? We are indebted to the careful studies of Tomes for much valuable information upon the origin and development of both the deciduous and the permanent teeth; but, like other investigators, Tomes has not always reached proper conclusions in his researches, and these require correction at the hands of his successors. These mistakes are most frequent in relation to the histology of the structures which he mentions, from his descriptions of which one can derive no clear idea of his meaning, or arrive at an accurate conception of the processes described. His methods of study seem to have been careful, but his conclusions are often erroneous.

The advent of the permanent teeth makes necessary a greater alveolar space than was necessary for the first teeth. The individual teeth are larger, longer and stronger than the deciduous teeth, thus requiring an increased arch for their accommodation, as well as a greater amount of bone for their proper fixation in their places. The additional teeth in each jaw also make necessary a greater amount of space for their growth. The question of the enlargement of the jawbone to provide for the greater number of teeth in it would seem to be easily determined by *prima facie* evidence; but, in reality, there has been much discussion upon the matter as to whether the jaw really naturally enlarges, whether the form of the arch is changed, whether the growth of the bone is peripheral, interstitial, or both, and, finally, whether the bone is larger in any way or not. There can be no question that the bone is materially increased in size and in weight, and that this increase is both peripheral and interstitial; but it is manifestly impossible to define by a mathematical equation the relative and absolute changes in the various parts of a bony structure having the complicated form and function of the alveolar arches. The various attempts which have been made to obtain accurate information upon this subject by means of operations on the bone are, in most cases, misleading, as they ignore almost completely the changes due to inflammation in and about the bone, which follows the operation, and may result in necrosis of the surrounding hard structures, or in some other accident of this kind, and thus obscure and nullify the experiment. There

should be a series of experiments on many animals under the most favorable conditions, and especially under the strictest aseptic and antiseptic precautions, and the mean result of all these experiments would give the best indication of the direction and amount of growth of the bone. The process of intermittent injections of coloring matter into the blood might be tried with advantage, and the course of recovery after fracture of the bone would be full of interest in the study of the direction of its growth. One experiment, or one series of experiments, can possess only a trifling worth in the study of physiological or pathological processes. A truthful result can only be obtained by long and patient studies by various methods and in many cases, and even then there is always a large margin for errors and various contingencies.

CHAPTER XIV.

ANOMALIES. FORMATIVE DEFECTS. DEFICIENCY OF TEETH.

Among the various abnormal conditions noticed in relation to the teeth, one of the most striking is that in respect to their number; that is, to the defective development of the germinative forms out of which the primary teeth are later constructed. It is believed by many observers that the earlier races of human beings possessed a normal denture consisting of a considerably greater number of teeth than is at present found in the mouth, and that this enlarged original number of teeth has become diminished through the occurrence of changes in the surroundings of the human family, and through variations in the habits of living, and in the degree of civilization. Consequently, the present denture of the human species is considered, by a large number of naturalists, as the degenerated form of an originally larger denture. It is a fact that, among the variations of number in the development of the teeth, the deviation in the direction of *excess* of the normal denture is frequently observed. The increase in number of the teeth is looked upon by the believers in the "descent of man" as a partial reversion toward the earlier natural denture of the human race, and so far, as not distinctly pathological. The individual teeth so produced in excess of the usual number are

denominated "supernumerary teeth," and are probably more frequently situated in the incisive region than elsewhere in the jaw, and are also more frequently developed in the upper than in the lower jaw. The more common deviation from the normal denture is, however, in the direction of a diminished rather than an increased number of teeth, so that the tendency would seem to be toward a further reduction of the number of the dental organs, beyond that which has already occurred since the original denture of primeval man.

The causes operating to produce a congenital variation of the number of the teeth must be sought during that period in the existence of the individual at which the different tissues and organs are being developed, that is, during the intra-uterine or the embryonic period. The actual cause of these deviations is still surrounded with obscurity, but it would seem that some disturbance in the distribution of the germinal matter out of which the organs and tissues of the growing embryo are constructed, must be the original source of the disarrangement of the dental structures in most cases. If this should prove to be the correct theory, we may safely consider that the disturbance must occur, or at least commence, at a period somewhere in the earliest weeks of intra-uterine existence. At present the whole subject of the origin of congenital malformations is clouded by superstition and veiled in ignorance. In some cases it may be possible to ascribe the malformation to some known cause, as the defective constitutional condition of the parental organism, or some other potent cause

operating upon the maternal system at the period when the malformation of the embryonic structures is supposed to have occurred. The existence of certain diseases in the body of the mother, and notably the presence of Syphilis, is a frequent factor in the faulty construction of the fœtal organism. The effect of this malady upon the forming tissues of the embryo is to render them more frail and friable, and to diminish their power of resistance to any injurious influence, so that the organs and structures of an individual affected with this disease in its congenital form are more liable to take on morbid action than those of a healthy individual. It is quite probable that certain other constitutional affections are transmitted directly to the tissues of the offspring, without producing sufficient immediate change in the organs to attract attention.

In studying cases of supposed deficiency of the teeth it is necessary to observe the greatest caution in order to avoid mistake. The number and the individual character of the remaining teeth should be first ascertained, and a searching investigation must always be made in order to ascertain if there exist any mark by which the loss by extraction or decay of one or more missing teeth may be detected. Very frequently the patient cannot give a satisfactory account of the number of teeth originally possessed, or state if any have been lost. The existence of a depression in the alveolar process, indicating the absorption of the bone, is often a valuable hint from which the early extraction or loss of a tooth may be determined. The statements of the patient may be

innocently or willfully misleading. This is particularly liable to occur when any considerable number of teeth are represented, or believed to be congenitally absent. The absence of any of the teeth belonging to the normal denture is not a frequent occurrence, and the congenital absence of a larger number is particularly rare, and should be carefully investigated. A case is reported in one of the German journals in which there is represented a total deficiency of the permanent teeth, but there is some doubt as to the accuracy of the facts in the case. I do not know of any other case deserving credence. Cases of partial congenital deficiency of the teeth are more frequently reported, and many exist which are never reported, from the fact that their bearers are not aware that any abnormal formation of the oral organs exists; the patient experiences no discomfort, and knows no different condition. A case in illustration of the lesser defects of congenital character is known to the author, in which the primary dentition was normal in every respect, and ran its usual course, excepting that the lower central incisors were not shed until the fifteenth year. In the upper as well as in the lower jaw, however, there appeared only one pair of incisors in the second dentition, and curiously enough, there were in the upper jaw two strong and massive central incisors, but no laterals, while in the lower jaw there were no permanent central incisors, but there were two normally formed and shapely lateral incisors. There were never any centrals in this jaw. The upper incisors (centrals) were very large and there was a congenital cavity in each.

The teeth suffered no perceptible change for some years, but have recently been carefully filled with gold as a precautionary measure against their further decay. Since that time their condition has not altered. In any other part of the jaw than the incisive region, a congenital deficiency of the teeth is usually accompanied by a shortening and narrowing of the alveolar process, or of the whole jaw. This is the more noticeable when the deficiency occurs in the denture of the lower jaw. The distortion of the jaw is more marked when the molar region is the seat of the defect, as the alveolar process is there more massive. It would seem as if the alveolar process were arranged to accommodate only the number of teeth actually present, and not those which should normally be present, but which in these cases have not been developed. The deformities of the jaw accompanying deficiencies of the teeth may be very strongly marked, and are usually found to accord with the alveolar arrangement of those teeth which have been developed. Thus, we sometimes find that the alveolar process is greatly shortened on one or the other side, or the jaw may even be transposed bodily to one side, so that the interval between the two central incisors is no longer in the median line of the face, but is displaced to one side. Sometimes, though rarely, the deficiency is so great that only a few teeth are present in the jaw. Cases are recorded in which from two to four teeth composed all which had been developed in the jaw at adult life, and, curiously enough, these strongly marked deviations are often observed in the upper and lower jaw of the same individual.

Another fact which at first seems very striking is that the primary dentition is often perfectly normal in those cases in which the secondary teeth are more or less deficient in number. This is probably due to the fact that in the fœtal development of the individual there was a normal definition of the tooth germs for the primary dentition, but the secondary tooth germs were only partially developed. The secondary tooth can only be produced when the germ for its development has been deposited from the germ of the primary tooth. The deformity of the denture is often hereditary, being transmitted from one generation to another, and is sometimes observed in the successive children of a family much in the same way as the hereditary variation in the number of the fingers and toes is transmitted to successive generations. Some instances are on record in which a deformity of the parents is not reproduced in the same form in the children, but takes some other shape or appearance, oftentimes presenting an anomaly before unknown in the family history, although due to a common cause with the other varieties. One such case is as follows: The father of the family long ago suffered from some obscure trouble which was not recognized at the time, and was not made the subject of treatment. The history of this malady is somewhat uncertain, but from the description given by those who have observed it, it was similar to that of the course of Syphilis.

This man was the father of six children, of whom one was affected with epilepsy and died after reaching adult age, being for years a burden upon his

family, and during the last part of his life being almost an imbecile. Another, the second, has cleft palate, and had a very pronounced hare-lip. The third has obscure and grave nervous symptoms. Thus three out of six children present evidence of defective formative force, but each in a different form; and the patients do not themselves observe any connection, or trace any relation between these three members of this family. Another instance is that of a family in which the grandfather is supposed to have become infected with Syphilis, and to have transmitted this taint to his children. Of these, several were affected with Chorea, one was deformed and misshapen, and another lost all the permanent teeth upon the upper jaw at a period of life in which these organs are generally found in their best condition. Of the third generation in this strange family, three of the offspring are blind; while in the fourth generation, of which the members are still comparatively young, there is not yet the appearance of any outspoken deficiency, but the children are sickly and weak. In cases in which an original organic defect exists in a parent, it is nearly always propagated, and may often be detected in the offspring, although the particular manifestation of the defect may have taken a different form in the child from that which it presented in the parent. Defects of the mouth and teeth are among the most frequent lesions of this nature, and should, therefore, always be carefully studied, and the history of the case and the antecedents of the patient should be thoroughly investigated.

CHAPTER XV.

VARIATIONS IN SIZE AND LOCATION OF THE TEETH.

The size of the teeth is, as a general thing, tolerably uniform, being about the same for corresponding teeth in the majority of people, of whatever condition in life; later, there comes a time at which they naturally commence to exhibit the evidences of wear, and of the disintegration which is the result of long use, often hastened no doubt by carelessness and neglect. They at this time become gradually flattened by attrition, and frequently show the signs of atrophy of the pulp, or other serious changes due to disordered or suspended nutrition, or to the accidents and diseases to which the hard structures are liable in advanced life.

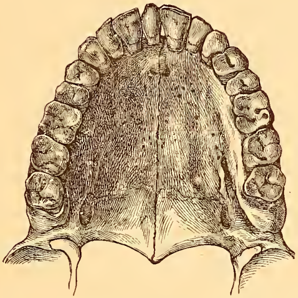
The denture is, however, subject to large variation in the size of individual or of associated teeth, and at times presents deformities of these organs which must be classed as monstrosities, and resemble the malformations occasionally observed in other parts of the body, by which the natural contour and the normal function of organs or of entire parts may be seriously compromised, or entirely obliterated.

The most frequent anomaly of form and size of the teeth is observed in individuals who from any reason possess teeth of a more delicate structure and smaller pattern than the majority. These organs may be perfectly healthy in structure, and may be

as durable as the teeth of most persons' so-called "sound" teeth: being in no way remarkable except from their diminutive size. In some cases the deciduous teeth may not be notably small, but the dental arch may be unusually large, and the teeth may be separated from each other by an unusual space, which gives to the organs collectively the appearance of being diminutive in size, because they do not fill the enlarged arch to the usual degree, and present spaces between the neighboring teeth. The enlarged spaces between the primary teeth are oftener observed in the incisive region than anywhere else, as here the alveolus is oftener abnormally lengthened than in any other part of its course. The teeth, too, in this region are more frequently of diminutive size. Sometimes it becomes necessary from cosmetic reasons to insert an artificial tooth to fill the space thus formed, and the artificial tooth is almost always placed between the central incisors, thus showing that it is in the intermaxillary region that most of these anomalies occur. The primary incisive teeth are often elongated and pointed like the canines; in cases of irregular development of the denture, it may therefore be difficult to determine the character of an individual tooth in this region. The body of the tooth so deformed is usually narrow and rounded in its contour, so that the entire tooth is really smaller than normal. The tooth or teeth thus affected may be perfectly healthy in structure and may possess a good degree of durability, being in no way remarkable excepting from their diminutive size. The milk teeth are in other cases so large

and strong that they are mistaken for permanent teeth, and they remain an unusually long time in the jaw, and are occasionally mistaken for a part of the permanent denture. In this case the teeth are much larger in proportion than is the dental ridge in which they are contained, and they are often situated at an angle in the jaw, or may overlap

FIG. 19.



A SUPERNUMERARY TOOTH SITUATED AT THE RIGHT SIDE OF THE MEDIAN LINE AND BETWEEN THE CENTRAL INCISORS OF THE UPPER JAW.

It has a conical crown, is well covered with enamel, and somewhat worn away transversely at the extremity. The incisors upon the right side slightly overlap, while those upon the left side stand within the dental range. The right segment of the dental arch extends about three millimetres more posteriorly than the left, on account of the insertion of the supernumerary tooth.

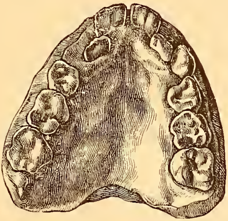
each other, and thus cause great distortion within the mouth; and at the same time they lay the foundation for a similar irregularity of arrangement in the teeth of the permanent denture. The primary set being too large to be properly accommodated in the space designed for these teeth, are obliged to assume any

position which will allow them to come to maturity, and thus are sometimes found far out of their proper line, and even protruding in a lateral direction from the jaw. The direction of the tooth must in these cases have been materially changed by the unusual crowding of the dental arch, and with the change in its location and direction there is associated a change in the position of its root. With this must be usually combined a malposition of the germ of the permanent tooth which is to follow it in the second denture.

The permanent tooth, which is in the meantime being developed in the tissues surrounding the root of the deciduous tooth and is already slowly approaching the surface of the gum, as the root of the primary tooth is absorbed to make room for its advance, thus takes an abnormal direction, and, finally, erupts from the mucous membrane in a direction and at a location far from the normal. This condition seldom affects one tooth alone; and occasionally the entire denture is affected and produces the distortion of the teeth, of which we see some notable examples in daily dispensary practice. At times the direction of the teeth may be varied from some accidental cause, when the teeth are not of unusual size and the alveolar arch is sufficiently capacious. The deformity may then be removed by careful treatment, in restoring the teeth to their normal position by means of gentle and prolonged traction in the desired direction, so that they will occupy their proper position, when the line of the dental arch will be perfectly restored and the normal contour of the jaw estab-

lished. It sometimes occurs that the teeth become so crowded and distorted by the large size of the individual organs, or by a diminution of the size of the arch, that one or more of their number may be mechanically forced into a position nearly or quite horizontal to their normal direction and to the alveolar process, thus lying at a right angle to the line of their proper growth. This condition does not frequently present itself, and when it really occurs it is often mistaken for some other malformation. It

FIG. 20.



A wedged-shaped narrow upper jaw of a young person, in which both lateral incisors have emerged upon the lingual side of the dental range, in consequence, perhaps, of some interruption in the development of the jaw, or, it may be, from the protracted retention of the lateral milk incisors. The right milk canine tooth has fallen out. (From a plaster cast.) Two-thirds natural size.

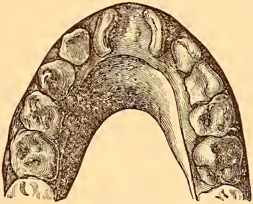
is more frequently observed in the upper jaw, and oftener affects the molar teeth than any others. The wisdom teeth are more frequently the seat of this deformity than all the other teeth together. This seems to be due partially to the fact that all the other teeth are already matured at the time when the wisdom teeth are erupted, and perhaps, also, because there is on one side of the wisdom teeth a firm wall composed of the teeth already grown and

in position, while upon the other is only the loose, cancellated structure of the posterior portion of the alveolar process, which has become softened and changed by the process of preparation for the wisdom tooth as it is about to protrude from it. If from any cause a slight change should occur in the direction of the growing wisdom tooth at this time, it might easily deviate from its normal line of growth to such an extent as to place its plane of advance entirely within the alveolar process, the tooth burrowing for itself a cavity in any direction which it may chance to take. Sometimes this is in an inward direction, when the crown may pierce the inner border of the alveolar-palatine region and appear as a prominence in the roof of the mouth.

The tooth may turn backward and outward and lead to the formation of a sinus, opening in the mucous membrane upon the labial surface of the gum. This was well illustrated in a case seen by the author not long since, in which a foul discharge had existed in the mouth for a long time. The patient was led to seek relief from the insufferable odor of the mouth as well as from the sickening taste and the persistent nausea which had lately been present. The discharge was traced to a small opening on the outer side of the gum, which was the orifice of a moderately large sinus, which had resisted repeated attempts for its obliteration at the hands of several experienced surgeons. At the time I saw the case, the opening was of the size of a pin's head, and passed obliquely into the soft tissues, upward and backward toward the spheno-maxillary fossa. At a depth of about two cm. a mass of hard tissue was

detected by the flexible steel probe, which was movable, though attached, not sensitive, and upon pressure over this point a large amount of putrid pus was expelled. By careful enlargement of the existing opening a view of the cavity and its contents was obtained, and the probe could now be passed entirely around a large body, which might be an encapsulated sequestrum, or it might be a misplaced tooth contained in a suppurating cavity. All opinions united upon the latter method of explanation, and a forceps

FIG. 21.



A twisting of both central upper incisors, occasioned, probably, by a hyperostosis in the palatal suture. The labial surfaces of both permanent central incisors are turned laterally, the lingual toward the median line; the lateral milk incisors are twisted laterally at an angle of nearly 45°; the milk molars are in their normal positions; the first permanent tooth has emerged. The maxillary arch is narrow. Natural size. (From a plaster cast, for the use of which the author is indebted to Prof. Strasky.)

was at once carefully applied, and a perfect tooth was grasped and at once removed from the deeper part of the cavity.

It occasionally happens that the tooth, particularly an incisor, is turned upon its axis, so that the edge instead of the broad surface is presented toward the lip, and the other edge is presented to the oral cavity. The tooth then is found with its surfaces transverse to the direction of the alveolar process.

CHAPTER XVI.

FUSION OF ADJACENT TEETH.

In certain cases there may be a fusion of adjacent teeth, in which they are so united as to present either the appearance of a simple junction of neighboring

FIG. 22.

Actual size.

SECOND PERMANENT MOLAR WITH FUSION OF ROOT TO BODY OF WISDOM TOOTH. WISDOM TOOTH IS CLUBBED AND EXTREMELY IRREGULAR IN FORMATION.

FIG. 23.

SECOND MOLAR WITH LONGITUDINAL FUSION TO BODY OF WISDOM TOOTH.

FIG 24.

SECOND PERMANENT MOLAR FUSED WITH WISDOM TOOTH, WHICH IS INVERTED. BODY OF WISDOM TOOTH IS CLUBBED, ROOTS ARE NOT DEVELOPED.

organs, or they may be joined in such a manner as to constitute a deformed and misshapen mass, conforming in no way to the usual shape or appearance of any normal tooth. This rare condition may

affect any of the teeth, and I have specimens showing the existence of fusion in different parts of the denture; but it is probably more frequently observed in connection with the wisdom teeth, which seem to present a marked tendency to abnormal formation of all kinds, and present the most frequent examples of partial or complete fusion.

At times the diagnosis of this condition becomes a matter of more than usual difficulty, owing to the seat and location of the fusion. It may affect the molar teeth, and the point of fusion may be situated near the root, so that there may be no external sign of the union of the adjacent organs; while in some cases the presence of a diseased condition of the soft tissues over and around the part may call attention to the possibility of fusion of the adjacent teeth as a cause. The existence of a long-standing and refractory discharge from the mucous membrane near to, or removed from the margin of the tooth, with the added feature that it is not amenable to the ordinary methods of treatment for this condition, should call attention to the radical fusion of the tooth which is visible, with some part of a deformed or misplaced organ which may be wholly contained beneath the surface of the mucous membrane, and can only be detected by careful examination, and possibly only after incision of the soft tissues. At times the tooth is contained within a chamber of bone, and it is necessary to excavate a passage in order to reach it, when it may be grasped with forceps and loosened, and then be removed in conjunction with the second tooth with which it is united. Two such cases are

known to me, and form a part of the morbid specimens collected for the purposes of instruction in the Boston Dental College. When fusion occurs in the incisive region, the teeth are more frequently united by their lateral borders; and less frequently present serious deviations of shape in the way of actual deformity, than in any other part of the denture. When the incisors are thus united, there is generally a longitudinal groove running from the edge of the massive fused tooth to the gingival border, at the line where fusion of the original separate organs occurred. The fusion may be confined simply to the exposed portion of the teeth, or it may extend to the extremity of the root, and thus form a complete union of the organs. In teeth in which the union is partial, the pulp canal is generally developed as a separate chamber in each portion of the double tooth, but in cases in which the fusion is complete to the apex of the root, there is usually one large and distorted pulp chamber, which serves for the entire double organ. Sometimes the crown is variously distorted, having an irregular number of cusps, arranged in the greatest confusion, or being traversed by chasms in the enamel, which run in various directions, showing an irregular or an intermittent growth of this organ. The teeth then often decay early, from the exposure of the dentine, which is easily attacked by carious disease, or from some inflammatory affection of the pulp or periosteum, induced by the exposed situation and imperfect condition of the crown, which thus leads to the extraction of such teeth, and so to the knowledge of the monstrosity which they constitute.

The patient frequently becomes aware of the existence of any peculiarity in the mouth only when his attention has been called to the condition of the oral organs by the dentist to whom he repairs for advice.

Another cause of malposition or deviation in the arrangement of the teeth is found in the existence of abnormal bony or cartilaginous growths in or near the alveolar process, such as exostosis, or hyperostosis, or some of the forms of enchondroma, or from the occurrence of inflammatory changes in the structure of the bone. The presence of the so-called cancerous growths in the soft parts about the teeth may also cause alveolar deformity by inducing absorption and softening of the bone, which allows the teeth to be easily pressed out of place and turned in any abnormal direction. The character of these growths will generally have been recognized before such extensive changes in the tissues and in the location of the oral organs has occurred. The malposition of the teeth in a case of the disease just mentioned would be a secondary process, and would depend upon the preëxistence of the malignant disease before mentioned. Treatment in such a case would not be directed to the distortion of the teeth, but to the eradication of the malignant and destructive disease which caused it, and would necessarily consist in the removal, if possible, of the entire mass of diseased tissue, with any teeth or other parts which might have become involved in the destructive process. The pathological growths of the gingival and labial region are of very diverse character, and pro-

duce varying results according to their seat, and the effect of the different forms of disease upon the parts in which they are situated. Many entirely different and distinct diseases of these regions have been grouped together by careless observers under the head of Epulis, and this faulty classification has done much to originate and perpetuate the confusion which has long existed in regard to the pathology of the various tumors of the oral cavity, and its immediate vicinity.

The term Epulis is a misnomer, as there is no form of disease which can properly be designated by this name. There are proper and characteristic appellations for all the pathological growths found in the neighborhood of the teeth and jaws. The diseases and other disturbed conditions of this region do not essentially differ from the same forms of disease in other parts of the body, and it is an error to add to the already large nomenclature of pathological conditions, by the introduction of special names for useless distinctions.

CHAPTER XVII.

RACHITIS.

A certain disease of the general system called Rachitis often produces great distortion and deformity in the hard structures of the body; and at times affects the jaws, occasioning more or less irregularity in the arrangement of the teeth. The seat of this lesion is in the bony structures, and is due to a mal-assimilation of the elements of the food taken; or to an actual deficiency of certain of the substances which are necessary in the system for the proper construction and preservation of these structures. In the condition which is induced by this disease, the bones are found in a softened state, the osseous skeleton is rarefied; the cancellous portion is diminished, the cells enlarged and the structures are very elastic, so that they yield to pressure, without fracture of the bone. The condition of the bone in cases of rachitic deformity is variable. The amount of animal matter in the osseous structures is much augmented and the earthy matters correspondingly diminished. The actual comparative weight of the fresh and of the dried bone would no doubt yield interesting results, but to my knowledge this has not yet been applied to the jaw. The rachitic bone can often be readily cut with a knife, and upon attempting to break it, a degree of flexibility is noticed which allows it to bend freely, but it will not break readily. The effect

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of the abnormal composition of the bony structures is more frequently observed in other parts of the body than in the jaws, where comparatively little pressure is directly brought to bear on the parts from external sources. A greater degree of deformity is observed in rachitis of the lower extremity, in which the bones are subject to greater distorting force; and they are often found to be bowed outward by the weight of the trunk in walking, at a time when the bone is too soft and flexible to support the strain. The joints at the knee and the ankle are often dislocated to a greater or less degree, and a deformity is thus produced which is not recovered from during a lifetime. Chemical analysis proves that the bones of a rachitic person contain less lime than those of healthy individuals. As this element is the principal one by which the strength of the bone and its resistance to injuries is secured, it is of the highest importance that it should be present in a sufficient amount to insure these ends. The diminution of the lime-salts in the bones would simply make them weak and brittle. The rachitic bone is flexible and elastic. This effect is the opposite to what we should expect, and it is produced by another deviation in the structural integrity of the bony tissues, which is a highly increased amount of the cartilaginous elements of the bone. At an early period of existence the greater part of all the bony structures is a mass of cartilage. The bones are "cast," as it were, in this soft, elastic material. A knife would easily cut them in any direction. Bone-tissue cells or blood-vessels are not found in any part, nor is the structure of bone to be

observed. All parts of the skeleton so far as it can be discerned at that time are composed of this uniform soft, pliant material. Very soon, however, a change in the histological elements is observable. Bone cells begin to present themselves in the borders, or at certain definite points in the cartilage, and soon a small spot may be perceived which is already hard, and opposes the knife. By chemical agencies the presence of lime may now be determined. The microscope shows the existence of the organic arrangement of true bony tissue. The bone cells are observed arranged in relation to the Haversian canals and sending off minute canaliculi into the calcareous mass by which they are surrounded. Blood-vessels are now observable, and the soft, gelatinous, vascular tissue of medullary substance becomes noticeable. A dense, firm layer of periosteum is found surrounding the bony formation, and sending prolongations into its interior, and the bone is thus rendered complete in all its physiological elements. In rachitic bone, this change of tissue has never been fully completed. The bones have indeed taken to their structure a large portion of lime, but they have never been fully ossified, and still contain a large amount of chondrine in their composition, by which they are rendered flexible at a time when they should be firm and unyielding. The weight of the body now becomes sufficient to bend the legs out of their proper line, and thus is produced the condition called "bowlegs." Other parts of the body may also become misshapen from this cause, as the back, and in women frequently the pelvis, and in some

cases other bones, among which the jaws are to be included, though a deformity of rachitic character in the jaws is among the rarer forms of this pathological condition.

The effect of this condition when present is twofold. It allows distortion in the arrangement of the primary denture, in which the teeth may be found at an angle to each other, and often twisted upon their axes, and otherwise displaced, and it also materially changes the relations of the germs of the second dentition, which are still within the alveolar process. The second dentition approaches its development at the proper period, but with the germs of the growing teeth so changed in direction that they often protrude in a very irregular manner. Sometimes the arrangement of the teeth may be so profoundly disturbed in their germ sockets that the tooth does not advance toward the free surface at all, but is entirely retained within the bony tissues, in a cavity which it forces for itself in the alveolus. In the various manifestations of the disease of which we have been speaking, we may always notice one peculiar fact, which is that the teeth themselves are never in the slightest degree altered in their structural elements or in their physiological development as individual organs by the presence of rachitis. The teeth in any rachitic condition of the bony structures at large are always found perfectly developed, as would be the case if rachitis did not exist. Thus, while one hard structure is profoundly affected and its functional integrity seriously interfered with, another neighboring hard structure is not at all affected by the same disease.

CHAPTER XVIII.

INFLAMMATORY AFFECTIONS.

Of all forms and varieties of pain to which the human subject is exposed, the distress occasioned by an inflammation seated in the pulp of the tooth and extending to the periosteum of the root, is probably one of the most agonizing. It is said that even the stolid and hardy Indian will shriek and moan like the veriest child under the agony of an inflammation of the tooth-pulp with its excruciating exacerbations. The pain from a tooth is said to be the only form of physical torture which will completely deprive the Indian of that firmness which renders him at once the admiration and the terror of all civilized people. It is the only excuse which he will himself think of offering or will receive from another for disability, without the taunt of cowardice.

There is not another structure in the human body in which the sensitive tissues are distributed in a manner so liable to cause distress upon the slightest insult or injury, and in which the slightest disease is accompanied by so astonishing an amount of pain as in the tooth. All through its vascular portion there is found an abundant distribution of sensitive nerve fibres accompanying every connective-tissue filament, and like it being only barely accommodated in its dentinal sheath. The slightest diminution in size of the dentinal canal, or the least infringement in its

calibre by pressure from without, must compress the delicate nerve filaments lying within it; and the least pressure upon a sensitive nerve filament means pain. An enlargement of the bulb of the nerve filament itself, from swelling or inflammation, would produce a similar effect, intensified by the presence of a diseased condition in its substance. When we think of a structure like that of the pulp of a tooth, consisting to so large an extent of nerve substance, and endowed with such exquisite functional integrity, we cannot wonder at the intensity of the pain which accompanies inflammatory conditions of these organs. The only surprising thing is, that in the constant state of use and of abuse of these organs, the instances of organic or functional disturbance of the dental structures are not more frequently noticed. The degree of immunity from directly injurious influences to which the teeth are continually subjected, is so great that scarcely one per cent. of cases of inflammation in these organs is due to any other cause than structural changes in the textures of the dental tissues, or to sudden mechanical insults inflicted upon them, or occurring in their immediate neighborhood. The causes which produce the remaining very large majority of cases may be any of the numerous lesions affecting the teeth; but by far the greater number are due to carious or necrotic conditions in or around the teeth themselves. In the greater number of cases the pulp cavity of the tooth has been opened by a carious perforation, and the delicate nerves contained therein have been exposed to irritation from foreign and external sub-

stances. Cases of simple inflammation, so-called "idiopathic" cases, are so rare that some good observers doubt their existence; and certainly a very accurate diagnosis must be formed, when caries is to be absolutely excluded. The irregular formation of some healthy teeth often simulates commencing caries, and is a constant source of distrust and concern to the careful dental surgeon; and this uncertainty is vastly increased when we are told that the same tooth is the seat of excruciating neuralgia. The similarity of symptoms in many cases of caries to those of commencing peridental disease is another constant source of uncertainty, as the pathology and treatment of these two conditions is in no wise the same.

In many cases, the only accurate method of forming a correct diagnosis is to observe the course of the disease. The behavior of the organs for a short time would do much toward deciding in favor of a pure necrosis, or an inflammation with its structural changes of tissue. The presence of inflammation is determined by the existence and sequence of certain phenomena, and the behavior of the tooth toward influences which usually produce no particular effects. The pain is often confined at first to one particular portion of the tooth, such as to one cusp of a molar, and the rest of the tooth is not only free from pain, but is not even sensitive to pressure upon it. The pain often increases in severity, and becomes disseminated, like other forms of neuralgic distress, until not only the whole of the diseased tooth, but also the neighboring teeth, become the seat of as great an amount of pain as the tooth first affected. At times

the sensory nerves distributed to the corresponding side of the face and head and neck are also affected, and the patient is at times unable to say where the pain is most intense. If we examine the tooth we shall generally discover the existence of caries in some part, which has penetrated, or has at least approached, the pulp cavity of the tooth. The pulp is exquisitely sensitive to any external impression. Particles of food, the atmosphere, cold, fluids, and various other substances, are sufficient to produce great pain, though at that time pressure upon any other part of the tooth may not be the occasion of any distress. For a time the pain seems to be of a purely neuralgic character, and to be unaccompanied by any positive inflammation of the dental textures, and while in this condition it is sometimes possible to remove the cause of irritation, by filling the cavity which usually exists, or by other appropriate measures, and the pain is thereby perfectly and permanently cured. The age of the individual has much to do with the character of the teeth, and with the personal susceptibility to pain. The existence of pregnancy is also accompanied, with a certain degree of frequency, by pain in the dental region, as well as in other parts of the body, and the termination of gestation is no less frequently the signal for complete relief from much distress in the teeth. The relief is often complete and unbroken, until the occurrence of the next pregnancy, when, after a period of a few weeks or months, there may be a return of all the distressing symptoms we have before seen developed in the patient, which endure, as at the earlier period, until the

patient is delivered, when they again suddenly cease. At times this series of phenomena is repeated through successive pregnancies, extending through many years. The teeth sometimes remain a remarkably long time in the same general condition, and under ordinary circumstances occasion the patient no uneasiness, but in the change which is produced in all the functions by the existence of pregnancy, they seem to become hyperæsthetic, and then often cause most acute suffering, until the ordinary condition of the system is once more restored. At times in the history of advancing caries, there may be a longer or shorter period in which slight causes will provoke excruciating pain, when the dentine has been reduced to a very thin layer which transmits to the pulp every sensitive impression of temperature or pressure, and often awakens most acute distress. This seems to be a simple traumatic neuralgia, and to depend upon external irritation, and not upon any degree of inflammation of the tooth pulp. The accessions of pain occur suddenly, and without premonition, subsiding gradually, and leaving the sufferer free from pain for a time, when they may recur on some new irritation being applied to the tooth. There is no heat or other appreciable sign of inflammation about the tooth. The time arrives, however, when the thin shell of dentine still remaining over the sensitive pulp is penetrated by the carious process. The tooth has gradually become more and more sensitive to changes of temperature, and to the presence of foreign bodies in its vicinity. The patient becomes more and more cautious in mastication and in taking

hot or cold substances into the mouth. At length mastication is no longer performed on that side of the jaw, on account of the pain caused by small particles of food in the cavity of the tooth. The patient is often obliged to avoid lying upon the affected side of the face when asleep, and is forced to exercise every care to avoid pain. At length a sudden acute pain occurs in the pulp, which often brings tears into the eyes of the strongest person, from its great severity, and at once renders the patient incapable of any effort other than to seek ease from the terrible agony. The advent of distress is usually occasioned by biting upon something, but at times it is impossible to determine the particular cause. The pain often seems to extend to other teeth than the one primarily affected, and sometimes even includes the entire distribution of that part of the fifth nerve. After a longer or shorter period the acute pain generally diminishes into a dull, extended ache, which subsides slowly, and at the end of some hours may have entirely ceased, so that the sufferer may for a short time be free from pain and may obtain some repose. The remission is generally of short duration, as the pulp is now exposed, and is liable to irritation from external influences of all kinds, when the same excruciating pain is sure to recur, to go through the same course of abatement and temporary relief as before. Another train of events takes place at this stage; the exposed pulp soon becomes inflamed, and this is accompanied by a different condition of the tooth and its surroundings than we have above considered.

The first appearance noticeable to an observer, is the redness of the pulp tissue, which generally is apparent at the point where the pulp is exposed, and is accompanied by a swollen and puffy condition of the soft parts, thus causing them to protrude from the orifice to a greater or less extent. At this period the pain is generally of a more continuous and wearing character than in the earlier stages of the disease, owing to a permanent pressure upon the delicate nerve fibres, caused by the swelling of the soft tissues within the unyielding structures of the tooth. The pain and swelling may be circumscribed, affecting only a single papilla of a molar, or it may be a general inflammation of the whole tooth. The former is more frequently the case where the perforation is very small and situated at one extremity of a tooth otherwise sound. The other form is observed in teeth which are much decayed, or in which the perforation is large, especially in a frail and weakly person. The redness may be very intense, owing to marked hyperæmia of the soft tissue, and often it amounts to hemorrhage into the pulp, as extravasation, such as may accompany other forms of acute inflammation. When there is an effusion of serum into the tissues, the color passes into a more or less intense yellow tinge, and soon assumes a greenish hue, due to commencing suppuration. Suppuration is the general consequence, or at least the common sequence of the inflammatory process, and is usually followed in the tooth by a cessation or, at all events, by a diminution of the pain, due to the disorganization of the tooth pulp by the inflammation, or to the atrophy of the nerve ele-

ments themselves, by which they cease to be painful. The examination of the pus from the cavity of a tooth presents nothing unusual. It consists of elements similar to those found in pus from other suppurations, viz., pus cells (white corpuscles of the blood), serum, mucus from the saliva, and débris of the adjacent tissues, together with various foreign materials which are introduced from without. These are most frequently found to be particles of cotton fibre, portions of food in different stages of disintegration, starch granules, bacterial forms, and a host of other variable substances which are either contained in the solids or liquids taken by the mouth or are inhaled or otherwise introduced from the outside. These are for the most part innocuous, as they are of small size and usually of soft structure; but some varieties are injurious from the results of chemical decomposition, which is easily induced in the mouth, and is accompanied by the liberation of deleterious gaseous and other products, by which the breath is made very offensive, and which must have an injurious effect upon the general health of the individual. The influence of suppuration upon the pain is produced by the structural changes induced by this process in the nerve elements. These delicate structures gradually lose the clear, sharp outline which they ordinarily present under the microscope, and become cloudy, indistinct and granular. The cell elements undergo fatty degeneration, by which their functional integrity is destroyed, and soon they are seen to become broken up into irregular masses of a friable nature, which are cast off like any other necrosed tissue.

The fatty degeneration and necrosis is prolonged into the fine canals of the dentine, and here is often accompanied by decomposition of the cell elements, with the evolution of a fetid odor and the feeling of malaise on the part of the patient, not to be confounded with any other similar condition unless with that of commencing typhoid fever. The dentine and enamel are often discolored from the action of the decomposing matter, so that the teeth become of a tan- or even deep-brown color, and lose their lustre, seeming more like the charred ends of bone than like the teeth. The pain often diminishes in a notable manner in these advanced stages of the disease, so that the patient is in no suffering, and the teeth often do service long after they are deprived of sensation, these being the "dead teeth" so often spoken of by dentists. They cause little or no irritation to the tissues surrounding them, and, being deprived of their original vitality, are retained in place as innocent foreign bodies would be, and are frequently of great use in mastication. They sometimes wear away rapidly at the crown, and become much grooved and beveled by attrition, but otherwise are often free from destructive changes. Sometimes they become, to a greater or less extent, separated from the gums or mucous membrane, so that they are loosened, and allow foreign substances, like tartar, to penetrate toward the root of the tooth. This also allows the decomposition of the particles which lodge there in eating. The careful and regular use of a proper tooth brush is here indispensable, if the tooth is to be saved, as otherwise the process of suppuration may

be set up, and may advance to such an extent as to allow the tooth to fall out by the merest accident, or even in chewing.

The food should be selected with reference to the condition of the teeth, and all hard substances should be sedulously avoided. In some cases the injurious effects of certain articles of food may be observed by means of their destructive chemical action upon the teeth. By this cause the teeth are sometimes so eroded and excavated that they scarcely protrude above the gums, but appear as brownish elevations in the alveolar line. In this condition they may still exist for many years without further appreciable change, and may even render considerable service in mastication.

CHAPTER XIX.

GANGRENE OF THE PULP.

Another variety of disease of the pulp cavity is sometimes observed, in which the soft tissues of the interior of the tooth become gangrenous, and awaken a new train of symptoms, due to the dangerous character of the changes accompanying this condition. This affection occurs more frequently in children after the more acute form of inflammation of the pulp, following caries, especially of the deciduous teeth. It is also occasionally observed as a consequence of diseased conditions of the periosteum or other peridental structures. In certain cases no cause can be assigned for its appearance, although it would seem that some irritation must have been present, as it is difficult to understand how the gangrenous condition could have arisen as an idiopathic affection. From whatever source it may have originated, the result is the same. It almost invariably causes the destruction of the pulp contents, either through a process of mummification by which all the moisture is abstracted from the tissues, and the pulp is left as a shriveled and dried mass of much less volume than it formerly possessed, lying in the original pulp cavity; or, as is more frequently the case, the whole mass breaks down rapidly into a uniform cheesy, greasy, smeary substance, containing the elements of the tooth pulp, which have been reduced

by sudden decomposition, associated with fatty degeneration, to this condition.

The general character of the case is similar to that of gangrene of any other soft, moist tissue of the body, and is at times observed in wounds, or more frequently in certain cases of pulmonary disease. The decomposition of the fatty products sometimes occurs, with the formation of the fatty acids which may be discovered in the mass, by means of the microscope, as long, needle-shaped crystals, either single or collected into clumps of varying size. These can be tested by proper reagents in the same manner as other chemical substances. The caustic alkalies are capable of forming a solution with fatty substances, when united with them by the aid of heat. They become saponified, and are then soluble in water. Bacteria are also generally found in cases of gangrene after acute inflammation. These organisms are intimately associated with the process of putrefaction in animal tissues, and seem to be a necessary factor in the production of this change. They possess different degrees of importance or else the body is variously susceptible to them, for they are at times vastly more abundant, and much more potent in their influence upon the system than at others. These bodies are introduced into the organism from without, and are not originally produced within the system under any circumstances. They swarm in all putrefying wounds and are found in thousands in the liquid which escapes from such wounds. They increase in number with astonishing rapidity, by a proliferation from the parent organism. They are seen to move about

in the liquid in which they are found, but this quality is thought to depend upon molecular activity, rather than upon any power of direct locomotion in the organisms. The nature of the bacteria has long been a matter of dispute between pathologists, but it is now considered as definitely settled that they belong to the lowest ranks of the vegetable organisms, and they are included among the cryptogams or schizomycetes. These low forms of organic life are transmitted by means of germs contained in the atmosphere, or by the use of implements or instruments which are contaminated by bacterial forms in some stage of their existence. The great mortality which attended all general surgery in hospital practice in the years gone by, was due in great measure to the infection of open wounds by bacteria, or by their germs; and the history of almost every hospital institution presents appalling records of mortality from the most trivial injuries and the slightest operations. One of the greatest triumphs of the present century has been the development and successful introduction of the Lister system of antiseptic surgery, by means of which a wound is placed under conditions which render it impossible for any septic material to gain entrance from the outside air, and recovery is usually then rapid and complete, and is free from the dangerous complications so often met in earlier times. Indeed, many operations which were formerly considered as especially dangerous, are now attempted with full confidence in a successful result.

CHAPTER XX.

CHRONIC INFLAMMATION OF THE TOOTH AND ALVEOLAR PROCESS.

Besides the acute inflammatory diseases connected with the tooth pulp, which we have above considered, there is another form of this process, a slow, persistent, chronic form of the same condition, which is developed slowly, progresses very moderately, and lasts indefinitely. There are in these cases usually none of the violent symptoms which make themselves so painfully manifest in the acute forms of the disease. The disease may occur as a consequence of caries, or in the history of some other affection of the tooth. There is first a swelling of the soft tissues, as the result of the caries, which nearly always attends this form of the disease, but the swelling is not so marked as in the acute forms, and is productive of comparatively little pain; or may occasionally cause no distress whatever. There is generally a circumscribed area of suppuration, but the discharge is of a sanious character, and not abundant. The odor is often offensive, from the decomposition of the elements of the dental tissues, the reaction of the decayed masses is generally acid, and the chemical action of this upon the dentine is to soften it by means of decalcification, and so to allow it to break down easily. The various external influences to which the teeth are exposed, such as ex-

tremes of heat and cold, etc., produce pain. When the discharge continues for a long time there is often noticed a wearing away of the tooth about the spot, where it looks as if it were eroded or chemically disintegrated. This is generally due to the action of the purulent fluid to which the dentine is continuously exposed, and which acts as a solvent to it and produces a gradual absorption of the calcareous elements, thus depriving that portion of the tooth of the firmness and resistance necessary to the performance of its function. The softened dentine is held in place by the cohesion of its particles, and by the protection of the neighboring parts, and acts as a focus for the further destruction of dentinal tissues. The other forms of inflammation which are confined to the tooth alone are very rarely met with, but may properly be mentioned at this place. The forms of idiopathic abscess sometimes observed, in which there is a collection of inflammatory products in the substance of the tooth itself, without any symptoms of caries or other affection, are very striking illustrations of this. The most of the cases now on record are from the lower animals, especially the elephant and the horse. In them these imperfections are much more common, on account partially, doubtless, of the larger size of the teeth, as well as from the fact that they are also much more noticeable than these organs are in many smaller animals.

The elephant, too, presents another structure, the tusk, in which evidences of obscure inflammations are at times observable, in the shape of deposits of various character. In certain instances the mark

of a previous injury are also present, and explain the diseased condition. Fractures which have healed in an irregular manner are one of the frequent causes of this condition, as also are penetrating wounds of the enamel structure, when such wounds have not been followed by acute inflammation; besides which probably the same result may be produced by many other causative affections of various kinds. An instance of this character came within the personal knowledge of the writer, only a short time since. The tusk from an elephant presented within the shaft of ivory a mass of bony tissue, of spherical form, inclosing as in a capsule, a large bullet. There were no evidences of atrophy of the tusk, or of any interference with its growth or functions, but it seemed as if nature had incased the foreign substance in an envelope of dense bone, and had there retained it in a harmless condition. A careful examination of the tusk showed no connection between the bony capsule around the bullet and the maxillary bone, and the question how to explain the presence of an island of bone in an ivory structure seemed a difficult one to answer. A probable solution of the remarkable condition is that the animal received the bullet long ago, and not in the tusk, but in the maxillary bone at a point within the matrix of the tusk. The wound closed, after a certain amount of irritation, and probably also suppurative inflammation. The irritation of the bullet stimulated the maxillary bone to a proliferation of bone tissue about the irritating body, the bullet was incased within a bony sheath, by which it was isolated, and thus rendered

harmless. The same principle may be observed within a beehive, where any offending substance is inclosed within a wall of wax, and thus hermetically sealed. The tusk continued growing, and carried the foreign body mechanically with it. In the slow process of growth, as the bullet became further and further removed from the matrix of the tusk, the connection between the bony capsule and the bone of the matrix became more and more attenuated, until at length it was entirely obliterated. Nature rounded the corners, and the growth of the tusk transported the entire mass further and further from the matrix until, at a period many years afterward, the animal died; and in preparing the ivory for manufacturing purposes, the iron bullet, surrounded by its compact bony capsule, was found far removed from the matrix of the tusk, within the substance of which the bullet had originally lain, and from which it had been transported a great distance by the natural processes of growth. The covering was perfect, the osseous tissue seemed denser than usual, and was everywhere closely applied to the bullet. There were no signs of an abscess or other inflammatory process in the vicinity of the spot, and it is not probable that the bullet would have ever afterward been the cause of any further trouble.

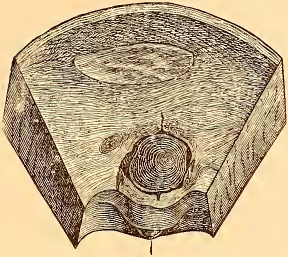
It will be seen that the presence of a foreign body in the bony matrix of an elephant's tusk might lead to the deposition of new bone about the location of the injury, by which it might become firmly encased in this material, and that this deposit or hypertrophy of bone might be mechanically transported along the

shaft by the growth of the tusk, and thus account in a reasonable manner for the presence of true bone tissue in the midst of the dentine, at a considerable distance from any other bony structure. The result of this accident might not be a source of permanent detriment either to the animal or to the organ affected. The original wound gradually heals, the matrix of the dentine becomes restored, and the tusk slowly protrudes from its sheath as if nothing unusual had occurred.

The well-known "Handbook" of Prof. Wedl contains an account of similar conditions in the tusks of elephants, but most of these have passed through the process of suppurative inflammation, and present cavities of variable size, some as large as a small orange. These cavities are uniformly described as being inclosed by a capsule of various tissues, within which was usually found a layer of dried and shriveled substance of a black or yellowish color, which was probably once soft tissue thrown out by the inflamed structures, in which the suppurative process was at that time carried on.

There is a lack of care in the reported observations in regard to the seat of the original lesion, and the probable time which had elapsed since the occurrence of the injury. If the injury should occur in adult life, and in the shaft of the tusk, it is difficult to believe that bone tissue could be formed about it. We know of no way by which bone could be proliferated in the midst of tissues of another character, as the product of an irritative process in these tissues. In no inflammation of any of the soft tissues

FIG. 25.



Segment from the tusk of an elephant, containing an iron ball which has penetrated as far as the pulp cavity and has formed a bulging protuberance upon its wall which has given rise to several superficially smooth, warty, new formations with broad bases, partially visible at (*a*) in the oblique view of the preparation. In the immediate vicinity of the ball, the cavities of small abscesses and also osteo-dentine, are perceptible. Two-thirds natural size.

FIG. 26.

A portion of a transverse section of the molar from an Elephas Indicus from Ceylon, containing the flattened segment of a leaden ball. (For the use of this specimen the author is indebted to Prof. D. L. Schmarda.) If the three dental substances be traced out, it will be seen that the enamel (*a*, *a*), at a certain distance from the fragment of the ball, and also the dentine (*b*, *b*), have been displaced by a substance (*c*, *c*), which forms an investment of varying thickness around the fragment of the ball and, when traced further, is found to enter into immediate connection with the cement. Hence the new formation was developed by a proliferation into the enamel and dentine. Natural size.—*Wedl.*

of the body do we see the formation of new bone as an independent structure, nor do we consider it reasonable to expect any permanent new structure of a character different from that of the surroundings to be produced in any location.

FIG. 27.

An osseous new formation from the wall of the cavity of an abscess in the tusk of an elephant. From the internal surface (*a*) of the cavity of the abscess as far as (*c*), where the normal dentine commences, the dentine is displaced by an abundantly vascularized osseous layer. The blood vessels are transversely divided, for the most part, and are surrounded by a luminous ring. The opaque dotted portions (*b*) correspond with the localities where granular cloudiness is visible, and, here and there, the remains of the ivory may still be recognized. The brighter spots contain, for the most part, bone-corpuscles which appear in the figure in the form of puncta; in many places, *e. g.*, near the middle portion (indicated by transverse lines), the bone-corpuscles are wanting, and in place of them is seen merely a diffused, granular mass. At the zone of transition into normal dentine (*c*), quite bright spots are perceptible on the right side, which are suggestive of clustered globular masses; upon the left are the openings of transversely and obliquely divided blood vessels, which are surrounded by a luminous ring and are imbedded within the dentinal substance. Magnified five diameters.

In inflammation of bone, however, we often find hypertrophy of the bone tissue, and a frequent example is met with in recent fractures, and in fact, in almost any injury to the bones. The most instructive illustration that I know, however, is afforded by

the study of the process of necrosis in bone. The diseased condition consists of the death of a portion of the bone, perhaps only a small scale upon the surface, or it may be a section of the entire cylinder. This becomes at once a foreign body, and being deprived of nourishment, speedily loses its vitality. It immediately enters upon a course of retrogressive changes, and becomes a source of irritation to the neighboring tissues. The periosteum is detached from the surface of the necrosed portion, the soft tissues about the same become swollen and inflamed; and a line of demarkation is soon apparent, consisting of granulation tissue which has been thrown out around the dead bone. This forms a wall about the dead portion, which serves as a protection to the system, by preventing the absorption of any product of the necrosis, or of its subsequent processes, which might operate to the great detriment of the whole body. Gradually the connection of the necrosed portion with the healthy parts is dissolved by the process of demarkation at the line of the living part, and after a time the dead bone is found as a white necrosed mass lying loose and perfectly detached in a cavity of the healthy bone. The periosteum has for its function the production of bone, and when it is irritated or moderately inflamed the result of the increased vital activity in this tissue is an augmented size of the bone already existing in the part. The presence of a portion of dead bone in an unwounded part has for its first effect the irritation and inflammation in a subacute form of the periosteum. The increased activity of this membrane is followed

by an augmentation of its specific product, and as the membrane is expanded over the surface of the dead bone, the product of the membrane is found in the shape of new bone upon the outer surface of the necrosis. Thus it occurs in many cases where the treatment of necrosis has long been delayed, that the dead bone is entirely inclosed by a shell of the new, living bone which has been produced by the action of the periosteum, and this shell must be pierced before the dead bone within can be reached. The shaft of the bone is oftentimes much enlarged by the deposition of new bone around it, and the soft parts are frequently the seat of extensive swelling or other disturbance. Not infrequently an acute suppuration attends the process, and after some time finds its way to the surface by means of a canal or sinus, which it forms for itself through the soft tissues At times there may be a tendency for the pus to flow along the surface of the healthy bone, thus lifting the periosteum up from the surface of the bone. This causes an extension of the original disease, and increases the amount of the necrosis, which is followed by a corresponding aggravation of all the subsequent phenomena connected with it.

CHAPTER XXI.

CARIES.

Among the various pathological processes affecting the tissues of the dental organs, the peculiar degeneration of the tooth structure called "caries" deserves more than passing mention. This affection is one which acts upon the hard tissues of the tooth from without, and not from within, though some authorities maintain that the deterioration of the general health of the patient, which diminishes the vigor of all the organs of the body, may so reduce the vitality of the teeth that these structures become affected with decay from the suspension of the customary and necessary nutrition of the dental organs through the medium of the pulp and its connections.*

Central Caries.† — "Many authors, Klencke among others, have asserted the existence of a caries which originates in the interior of the tooth, and in the cavity of the pulp. Nowadays most dentists pronouuce against the existence of a central caries. It is true that the process of destruction often begins in a minute crevice or furrow in the surface, and so penetrates the dentine, even to the pulp-cavity, where it performs its ravages, while the enamel of the surface seems intact, at least to a superficial ex-

* See exhaustive article on "Dental Caries," in "American System of Dentistry," Vol. I, page 729 *et seq.*

† Leber & Rottenstein. Translated by Thos. H. Chandler, D.M.D.

amination. This caries, though central, yet has its origin at the surface of the tooth. Therefore, in these latter days, the existence of a true central caries has been generally denied."

Such a claim seems plausible in some of the cases of rapid decay of the teeth seen in certain persons, but it is more than probable that other and unnoticed pathological conditions contribute to the sudden loss of the teeth in these instances.

Caries, in the ordinary acceptation of the term, is a degenerative process, which first appears upon some exposed and unprotected portion of the body of the tooth.

"Since caries begins ordinarily at the crown of the teeth, the caries of the enamel constitutes the first stage of the process. The destruction reaches the dentine later, but the first pathological phenomena make their appearance in it, even before the enamel is destroyed in its whole thickness. Most frequently there is seen a black or brownish point in one of the furrows or folds of the crown. On examining a section of the diseased portion, the dark color is seen to have its seat in the superficial layers of the enamel, and penetrates clear to the bottom of the furrow, where the thickness of the enamel is, in general, less than at the other points." *

It is of the nature of an advancing localized necrosis of the hard structures of the dental organs, which first appears as a spot of small size, and advances by extension to other portions of the tooth

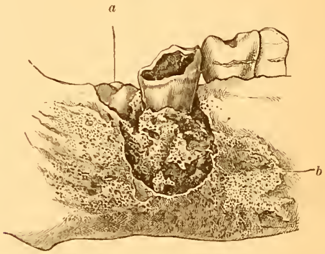
* Leber & Rottenstein. Translated by Thos. H. Chandler, D.M.D.

first invaded, and at length may attack the teeth adjacent to those primarily affected. The disease is of progressive character, and extends by continuity of tissue into new areas of the dental textures, which disappear before it, until the body of the tooth is extensively diseased and to a greater or less degree destroyed. As the disease approaches the cavity of the pulp canal, it awakens sensations of a dull pain, or a recurrent tenderness when pressure is exerted upon the tooth, which soon increases to a constant and agonizing distress, as the wall of the pulp canal becomes thinned by the advance of the carious process, until at length the pulp canal is opened, and the symptoms of an acute inflammation of this sensitive material are at once produced. This may be followed by suppuration within the cavity of the pulp canal, with the formation of an abscess at the root of the tooth, which may discharge through the pulp chamber and the perforation caused by the caries. Occasionally there is sudden and extensive necrosis of the soft tissues within the tooth, with the retention of the products of disintegration of tissue, which is sometimes followed by the signs of septic absorption and localized or general septicæmia. This is a serious condition under any circumstances, and is justly regarded by surgeons as a most dangerous complication. It is not frequent in affections of the teeth, but is occasionally observed, and has been the cause of death in cases of inflammation of the dental pulp.

When inflammation of the dental pulp is followed by alveolar abscess, there is not infrequently an ex-

tension of the destructive process to the wall of the alveolar cavity, with the necrosis of a portion of the bone situated at the apex of the root. There is then not infrequently a perforation of the body of the maxillary bone, with the formation of a swelling of more or less fluctuating character over the site of the disease. This sometimes goes on to the formation of a sinus to the surface of the skin, and the discharge

FIG. 28.



A circumscribed necrosis upon the lingual wall of the left lower maxillary arch, corresponding to the carious second molar: and also a finely porous osteophyte-formation upon the adjacent portion of the maxillary wall. The wisdom tooth (*a*) has just made its appearance. The discolored, necrosed portion is sharply defined, and adjacent to it is deposited a thin, finely-porous osteophyte, which spreads anteriorly upon the lingual surface as far as (*b*), and posteriorly nearly to the articular condyle. A fistulous opening was formed upon the facial wall of the jaw beneath the posterior root of the second molar. The porous osteophyte extends anteriorly upon this surface as far as the mental foramen and posteriorly to the condyloid process. Natural size.

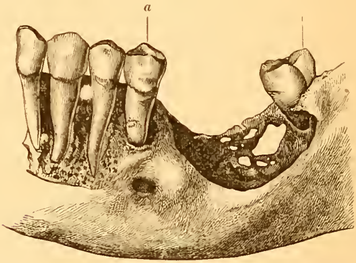
of purulent matter from it, with occasional portions of the necrosed and exfoliated bone which has been gradually loosened and extruded. The carious process may thus lead to other conditions, involving the tissues surrounding the teeth, and producing unexpected complications, which are at times of serious character.

The cause of the decay of the hard structures of the teeth has long been the subject of study, and various theories have been advanced as to the way in which the tissues are affected by the carious process. It was thought that the disease bore a close analogy to the affection of the bones of the spine, the long bones of the extremities, etc., which commonly goes under the name of caries of these osseous structures; but a closer study of the two diseases shows that the processes affecting these different hard structures in no way resemble each other. Caries of the bones is an affection associated with either the previous occurrence of an injury, or it appears subsequent to a period of marked debility of the general health, or, third, it may be observed in patients who are the subject of scrofulous diathesis, of syphilis (hereditary), or are the victims of some other serious contamination, of inherited or acquired origin. The bones in these subjects are found to be softened, they present larger or smaller cavities in their substance, and they are frequently partially or entirely denuded of periosteum over those portions which are the seat of the carious process. When the vertebræ, or the bones forming the hip joint, are affected with caries, the bones are frequently much eroded, and often are more or less broken down, causing a great degree of disability, and producing marked deformity.

Suppuration frequently occurs in the substance of the diseased bone or in its vicinity, and at times there is observed the formation of a well-defined abscess at the seat of the disease, which may perforate

the tissues and open upon the surface, or burrow its way along the track of the larger muscles, and form a fluctuating swelling in some adjacent part of the body. Caries of the bones may, under favorable conditions, end in complete recovery. There is not infrequently a permanent deformity of the part which was the seat of the caries, and there is often a bony anchylosis of the affected structures, so that subsequent disability of function supervenes; but

FIG. 29.



A segment of the left lower maxillary arch, in which is the cicatrix of a circumscribed necrosis of the alveolar process, corresponding to the first and second molars. The mental foramen, somewhat more posteriorly than usual, is situated underneath the apex of the root of the second bicuspid (*a*). The facial wall of the three front teeth is removed.

the carious condition may be entirely recovered from. Patients who have once recovered from caries of the bone seem to be free from any tendency to a return of the disease.

In the occurrence of caries of the teeth, none of the peculiar features noticed in caries of the bones are observed. There is no tendency to suppuration, properly so called; there is seldom an extension of

the disease to the alveolus or to the jaw, and there is usually no tendency toward recovery. The tooth which is attacked by the carious process is not likely to recover from the malady, but the disease is progressive, and rapidly invades new portions of the dental structure, until the entire body of the tooth has been softened and destroyed, the pulp canal has been uncovered, followed by acute inflammation of the contents of the pulp-chamber, and the death of the tooth. It is a curious fact that caries of the teeth usually extends only to the level of the gum, and there stops, so that the roots and that part of the body of the tooth which is embraced by the surrounding tissues are retained for an indefinite period after the body and crown of the tooth have been entirely removed by the carious process.

CHAPTER XXII.

CAUSES OF CARIES.

The cause of caries, its manner of origin, and the particular conditions which predispose to its occurrence have long been questions of interest to the dentist. Many observations have been made to determine the nature of the process by which the most resistant tissues of the body are thus destroyed. A gradual consensus of opinion has been reached, in which nearly all observers now unite. The accepted theory of dental caries seems to be that the disease is one which always arises from external causes, and is due to external influences. The destruction always begins upon the exterior of the tooth. It is usually observed upon the surface of the enamel, and in most instances the point of origin of the disease is situated upon the surface of a cusp, or in a sulcus of the crown, or upon the surface of enamel which lies in proximity to an adjacent tooth.

"The surface of the enamel is irregular, and presents inequalities and depressions more or less developed, and which may be few in number or scattered over the whole surface of the crown. These teeth are sometimes designated as "honeycombed teeth," from their resemblance to that article. In other cases we see the cutting edge of incisors notched or toothed, and sometimes of a conical shape, both of

which forms are caused by deficiency of the enamel; or the teeth contain parallel furrows crossing them horizontally. The name of erosion is given to these lesions, which show themselves at once upon several teeth, and yet they are but incomplete developments of the enamel, which have of erosion only the form. Finally, the enamel is sometimes completely wanting upon a greater or less extent of the crown. The anomalies just described must be only too favorable to the establishment of caries, inasmuch as the agents of an injurious nature deposited in the cavities and irregularities of the teeth can extend their action without obstacle, and much better than on a polished surface. Fissures of the enamel occasioned by sudden changes of the temperature may exercise the same influence. Doubts have been raised upon the possibility of seeing fissures of the enamel caused by changes of temperature, but these fissures are sufficiently frequent. In many cases the enamel of the greater number of the teeth, and sometimes, even of all, is seen covered with chinks in every direction. They are most frequently caused by sudden changes of temperature, but sometimes are due to traumatic action.

"No one at this day can refuse to believe in the necessity of the action of acids to occasion caries of the teeth. The salts contained in the enamel and in the dentine cannot be dissolved in water; acids are indispensable to work their solution. But it is not at all necessary to employ strong acids for the purpose of separating the carbonic or even the phos-

phoric acid from the lime with which they are combined.

"Mr. A. Westcott and Mr. Dalrymple found that all the mineral, as well as vegetable acids, act promptly upon the teeth. Acetic and citric acids, for example, in forty-eight hours corroded the enamel to such a degree as to permit a great portion of it to be scratched away with the nail; malic acid also produced very rapid effects.

"The salts whose acids have a greater affinity for lime than for their own bases also acted upon the teeth. The acid tartrate of lime very rapidly destroyed the enamel.

"Vegetable substances have no action until they ferment, and acetic acid is formed. Sugar, for example, which by itself has no action, produced its effects only in a state of acid fermentation.

"Animal substances acted only very slowly, and only when they had reached a very advanced stage of putrefaction.

"We have found that all substances capable of changing the dental tissues produce, at first, a deterioration of the enamel, which is soon followed by that of the dentine. The enamel, which in its normal state, is transparent, becomes quite opaque, milky, and in a more advanced state, chalky.

"Our experiments are in harmony with those of Mr. Westcott and of Mr. Allport, and of Mantegazza, who found that all the vegetable acids without distinction attack the enamel of the teeth.

"The different action of acids upon the different

tissues of the teeth is explained by the presence of variable proportions of organic substances which enter into the composition of the enamel, the dentine, and the cement.

"After having established that acids of the most various kinds attack the teeth, it behooves us to inquire what are the acids which take part in the caries of the teeth, and how they get in the mouth. We know that acids are always introduced into the mouth with our food and drink. Acetic acid is associated with great numbers of viands as a condiment; malic, citric and tartaric acids are found in different kinds of fruit, and in the drinks which are made from them; oxalic acid is found in certain plants; lactic acid in sour milk, etc. We have moreover pharmaceutic remedies which contain mineral acids and their acid ethers; then tannin, some salts, alum for instance, are able to attack the teeth. All these substances may easily bring on caries or contribute to hasten its progress; but we think that the acid formed in the mouth as the result of decomposition, or those which are found in the buccal secretions, play in this manner a much more important part. As far as we know the veritable nature of the acids found in the mouth has not yet been demonstrated by any direct experiment, nevertheless, it is generally thought to be lactic acid, and this opinion has greater probabilities in its favor."*

The disease may at times appear upon the surface of the cementum, when this is exposed by recession of

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* Leber & Rottenstein. Translated by Thos. H. Chandler, D.M.D.

the gum or other causes, but by far the most frequent seat of origin of the carious process is the enamel surface of the crown of the tooth. The disease first appears as a spot of small size, and is usually observable from a change of color; the point of decay being usually of a brownish tint, which is easily perceived upon the pearly white of the surrounding surface. The textures of the tooth are found softened, they have lost the normal consistence of enamel, and often it is observed that the disease has extended through the enamel, and has involved the dentine lying below it. The character of the change in the tissues of the teeth in the process of decay is believed to be a chemical decomposition of the calcareous structures comprising the body of the tooth.* This is thought to be due to the action of acids upon the alkaline textures of the body of the tooth, whereby new chemical substances are formed, which are in no wise similar to those of the normal tissues, and therefore are incapable of fulfilling the offices of these structures.

Leber and Rottenstein state that "in our opinion the progress of caries of the enamel is this: By the action of an acid, the enamel becomes porous at some point, and loses its normal consistence. At the same time there is seen to appear a brown color, in consequence of the change which has taken place in its organic structure. There is formed at the surface a bed of leptothrix, which probably pene-

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* See also "Treatise on Dental Caries," by Dr. E. Magitot. Translated by Thos. Chandler, D.M.D., Dean of Harvard Dental School. Page 121 *et seq.*

trates the dental cuticle, if it still exists, and destroys it. Chinks and fissures open in the enamel, which has become less consistent. Acid liquids and granulations of leptothrix penetrate there, while minute fragments become detached, and are promptly enveloped by the elements of leptothrix, which, joined by the continued action of the acids, hasten the dissolution."

The source of the acid substances which thus act to destroy the tooth is thought to be the decomposition of saccharine matter or other materials which are capable of undergoing acid fermentation. The result of such fermentation is the formation of acetic, butyric, lactic or other organic acids, which from their known relation to alkaline bodies attack the tissues of the tooth substance, if they are allowed to remain for a sufficient length of time in contact with these organs.

The result of this action is the formation of various chemical salts in the tooth substance, with softening of the material formed, and the progressive destruction of the substance of the tooth. The seat of commencing decay is also invaded by the germs of various organic bodies called bacteria, which are always found in situations where decomposition (putrefaction) is going on, and were at one time supposed to be the active factors in the production of the changes accompanying caries. This view has now been pretty generally abandoned, and these minute organisms are thought to be the universal accompaniments of the carious process, but are not believed to be its active cause. They are very

minute in size, and are found in other situations than the teeth, if putrefaction be present. They are thought to act to some degree the part of scavengers in the organism, and to produce further chemical changes in the decomposing mass in which they are contained, by which it is in some cases rendered less

Fig. 30.

Softened, carious dentine, from a reinserted human tooth. Proliferations of leptothrix-matrix have taken place from irregular, pouch-like excavations into the dentine, along the course of the canals. Magnified 500 diameters.

dangerous to the system. At all events, these germs are found in all cases of decay of the teeth, and may be observed by proper means of examination under the microscope. They are not detected in the tissues of healthy teeth, but are universally present in the contents of the excavations made by decay.

Leber and Rottenstein have remarked "that the action of acids alone does not account for all the phenomena which appear in caries of the teeth. It is true that acids, even very much diluted, can attack the dental tissues, but we find, in their mode of action, differences which distinguish them from the phenomena, and from the progress of dental caries. The acids attack first the enamel and rapidly change it to a chalky mass; later only, their action is felt in a marked manner upon the dentine, which becomes more transparent, and in fine, as if cartilaginous, by the very slow but progressive loss of its calcareous salts. Caries, on the contrary, proceeds slowly in the enamel; it is much swifter in the dentine, where it proceeds promptly along the canaliculi. This difference of progress must be attributed to the participation of the fungi in the work of the caries. The elements of the fungus glide easily into the interior of the canaliculi, which they dilate, and thus favor the passage of the acids into deeper parts; these same elements cannot penetrate a compact enamel, or at least they enter more slowly, and only when the elements which form it have been greatly changed by the action of acids.

"But while, in ordinary circumstances, the fungi are found only at the surface of the buccal cavity, they are seen to penetrate into the interior of teeth during the progress of caries. For them to be able to penetrate thus it is necessary that the teeth be in a suitable condition; the enamel and the dentine must have lost their density by the action of acids.

The opinion that caries is due to chemical changes

in the tooth substance, and not to the penetration of the tissues of the tooth by bacteria, is further strengthened by the fact that when the carious matter is entirely removed, it is possible to preserve the tooth from further damage, by protecting the surface thus prepared from further chemical change by covering it with some material capable of preventing further access of injurious materials to the diseased portion, and thus avoiding the chemical decomposition of the dental tissues. It would probably be quite impossible to eradicate every organic germ from the minute canals of the dentine, even if this were desirable. We already know that the air we breathe, continually contains germs of many kinds, and that certain organic germs are found in the mouth in conditions of health, and it is quite probable that these bodies are not the elements of disease in cases of caries, but are associated with the processes of chemical decomposition, and particularly with that of putrefaction. It is even thought that they absorb dangerous substances from the matter around them, and by a process similar to that of digestion, transform these deleterious substances into other and harmless material.

Caries of the teeth is most frequently observed in those persons who are not in the habit of carefully cleaning the teeth; or in those in whom the diet is in some important respect either insufficient or of a quality not suited to the proper development of the dental structures. In such individuals there is usually also a lack of care of the teeth, particles of food are allowed to remain in the interstices between the

teeth or in the depressions between the cusps, and there soon undergoes fermentative changes, with the production of acid substances, which immediately attack the structures of the dental organs. The time required for the decomposition of organic substances in the mouth is not long, as the conditions under which fermentation would arise and be favored are continually present in the oral cavity. The interior of the mouth is constantly moist and warm, two conditions essential for the process of chemical decomposition of the class of substances which are taken as food. The presence of decomposing substances in the mouth forms a favorite condition for the growth of bacterial organisms, which are invariably found as accompaniment of the carious process. The putrefying material derived from the destruction of the dental tissues, added to that resulting from the decomposition of the articles of food which is always associated with the carious process, forms a mass of offensive matter in the mouth which is the cause of a peculiar odor, easily observed by those in the vicinity of the patient.

The constant presence of decomposing matters in the mouth, and the continual inhalation of the putrid emanations from these substances with the breath, the fact that all the food which is swallowed is more or less contaminated from the admixture of foul and rotten substances, is a cause of deterioration of the general health and of a more rapid loss of the dental organs. With the loss of the power of mastication which the impaired condition of the teeth brings

about, there is added another element of deterioration of the general condition of the system, which augments the damage already produced by the disease in the mouth. The relations of caries of the teeth to the general health cannot be but seriously detrimental in its character, and should lead the careful practitioner to advise early treatment for the restraint of the disease. The origin of the diseased process in chemical decomposition of organic substances in the mouth, and the disintegration of the tooth substance by the action of acids, affords valuable aid in determining the means to be employed for the prevention of carious degeneration, or for its cure if once it has appeared. No method of treatment will be of permanent benefit which does not have for its aim the eradication of all traces of the disease, and the protection of the carious surface from the injurious action of substances capable of prolonging the malady. The methods at present most approved by competent practitioners consist in excavation of the cavity formed by the carious process, its careful disinfection by antiseptics, and the hermetical closure of the cavity by means of gold filling, or other appropriate substances. So long as the cavity thus treated is preserved in an aseptic condition, the process of decay is arrested. If, however, the surface of the diseased tissue be imperfectly covered, or if any portion of the disease be suffered to remain in the cavity, the destruction of the tooth will be only temporarily checked, and will sooner or later again become active.

In a few rare instances there seems to be an effort on the part of nature to stay the process of decay, and to preserve the tooth in a state of partial usefulness, even when the carious disease has become established. This may occur by the gradual formation of a new layer of dentine, or other hard material, probably not always the same, which is developed at the seat of the disease, and gradually extends over the situation of the carious degeneration, and forms an impervious protection to the true dental tissues beneath, so that they are not further affected by decay. This new deposition of tissue is usually seen in teeth which have become partially devitalized, and are not the seat of living pulp. The way in which this process is carried out is not well understood, but the result of it is to furnish a new portion of hard tissue, which covers the diseased tissues in much the same way that a proper filling would do, and thus stays the progress of the caries. At times there is observed a deposit of such material in the pulp chamber of teeth which are not the seat of known disease, and in this situation they are sometimes called "pulp stones." They are not known to possess any pathological importance, and are usually free from any indications of previous inflammation in the teeth in which they are found. At times there is an appearance similar to a mildly irritative process which is followed by a secondary deposit of dentinal tissue, and which may account for some of the pathological formations in the centre of the tooth; but observations upon this point are not yet suffi-

ciently numerous to warrant the statement of a positive opinion upon the subject.*

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* For an exhaustive and interesting treatise upon the nature of caries, and especially the relation which fungous organisms and the various fermentative processes bear to the destruction of the teeth by caries, see the admirable article on "Fermentation in the Human Mouth: Its Relation to Caries of the Teeth," by Prof. Dr. W. D. Miller, Berlin. Published in *Independent Practitioner*, 1884–85, and reprinted in "American System of Dentistry," Vol. I, page 791 *et seq.* "Dental Caries and Its Causes." Leber and Rottenstein. P. Blakiston, Son & Co., 1883.

CHAPTER XXIII.

NEUROSES OF THE TEETH AND FACE.

A large class of affections of the head and face are grouped under the head of Neuroses of these regions. These disturbances are not always the same in appearance, they do not manifest themselves at all times by the same symptoms, they are not always similar in their pathological relations, and their behavior is not uniform under similar methods of treatment or surroundings.

By the term "neurosis" is understood an affection which is sometimes confined to a restricted portion of the body, as to a certain limb or region of the body, or it may be distributed over a large area of the trunk or extremities, and include many different structures and organs in its domain. A peculiar feature of this condition is found in the fact that it is observed to follow the distribution of certain nervous trunks, and to be confined in its development, at least in its earlier stages, to the area of dissemination of definite nerves of sensory or motor character.

The seat of the disturbance which occasions the phenomena in any form of neurosis may be stated, in general terms, to be confined to one of three locations. It may be seated in the central nervous system, that is, in the substance of the brain or spinal cord; or, second, it may be located in the nerve trunks leading to the various peripheral regions of the body, or their

ganglia; or, third, it may be due to some affection of the distributory filaments or the nerve endings in the tissues to which they are distributed. These are not all of the same kind, as some of the nerves are directed to muscular tissue and cause the contraction of these fibres; some are devoted to ordinary sensation, and are the medium of our impressions of outside objects from contact, while another variety of nerves is devoted to special sensation, such as those distributed to the organs of sight, taste, hearing, etc. Any or all these nervous structures may be the seat of neuroses of different kinds.

The most frequent form of neurosis is that which finds expression in the form of *pain*, either localized in a limited area or disseminated over a considerable amount of the part affected. The general character of the pain is that of a lancinating or stinging sensation, which is sharply defined in its extent, and is not accompanied by any of the ordinary evidences of the processes of inflammation which usually cause the distress in cases in which there are inflammatory disturbances. There is usually no swelling, there is no marked elevation of the body temperature, nor is there increased heat in the part which is the seat of the distress. There is no disturbance of the normal functions of the body, except in so far as these may be hindered by the existence of pain. The skin is usually not changed in appearance; even when the pain is most acute, there is generally no observable deviation from the normal appearances, either at the seat of the distress or in its vicinity. At times there is marked disturb-

ance of function in the neighboring glandular structures, which during the paroxysms of pain may be found in a state of exaggerated functional activity. Thus, in cases of neuralgic pain in the area of distribution of the first, or ophthalmic branch of the fifth pair of nerves, there is often an augmented secretion of the lachrymal fluid, and the tears flow over the patient's cheek on the affected side, even when there is no inclination on the part of the patient to weep. In cases in which the third branch of the fifth pair, the inferior maxillary nerve, is the seat of pain, there is often increased secretion of the salivary fluids, from reflex irritation of the nervous elements controlling the action of these glands.

The pain in these cases is usually paroxysmal in character, frequently coming on without known cause, limited within sharply-defined boundaries, and frequently disappearing suddenly, leaving the part in a state of perfect health; to return again after an uncertain interval and run the same course anew. The characteristics of all the neuroses, of which the picture here presented of a common neuralgia depicts but one, are its peculiar quality of occasioning the most acute suffering without exciting the appearances of inflammation in the parts which are the seat of distress. The distress is paroxysmal in character, and is usually interrupted by intervals of complete relief, in which no trace of the malady can be perceived; nor can it usually be excited by ordinary causes. Added to this is the curious circumstance that when pain is excited in a certain limited part, the painful sensation is often transferred to other

parts and organs which are not the seat of any disease, but suffer from a distress which is due to *reflex* sensations arising from the primary neurosis in some other part of the body. An example of this is found in the frequent occurrence of agonizing neuralgia in the various branches of distribution of the fifth pair of nerves, which is observed during pregnancy, in which there is often absolutely no appreciable disease of the teeth or of their surroundings, but in which the pain is so intense that the patient's life is made a burden. Another form of the same condition is that in which there is persistent vomiting of reflex character, which at times so interferes with the nutrition that it becomes a serious peril to the life of the mother. After exposure to certain injurious climatic influences, there is often noticed a peculiar susceptibility on the part of the patient to neuralgic or other neurotic affections, which occasion a great degree of distress to the patient, and often reach a point of extreme severity.

There are a number of pathological conditions of the body which are accompanied by neuralgic pain as a constant symptom, which are not properly reckoned to the neuroses; because the distress is in them caused by, and is secondary to, a distinct preceding condition of disease of the part, or of the nervous trunks leading to it, and is therefore ranked among some of the recognized forms of pathological deviation of the tissues or organs, and constitutes an *organic disease* in distinction to a *functional disorder*. The causes of this group of disturbances may be classed in

a general way as belonging to the varieties of perineuritis, to the various forms of exostosis within the neural canals, or to the formation of tumors upon the trunks of the nerves or at their extremities, in all of which conditions there is usually an extreme degree of pain of neuralgic character. The first of these causes is probably by far the most frequent in the causation of the neuralgias due to pathological growths. These cases are most frequently observed after trauma of some kind, and especially after fracture of bones, or following surgical operations affecting bony tissue in the vicinity of the neural canals. As the result of these disturbances, there is awakened an irritation in the wall of the bony canal, or at its orifice, by which new bone is produced, which, if it be deposited within the canal, must diminish its calibre, and thus compress the nerve or other structure passing through the canal. The same thing is sometimes observed after infection with syphilis, and frequently follows the infective fevers—typhoid, diphtheria, etc.—though in these cases the cause is at times to be found in a thickening of the periosteal lining of the bony canal, which often subsides after recovery from the systemic disease. When the neuralgic distress is occasioned by disease, it is often possible to bring about a cure of the pain, by treatment of the general health, or of the condition of the body which has caused the disturbance, and which is frequently of an asthenic or debilitating character.

This class of maladies is particularly frequent in those persons who have been exposed to the influence of malarial conditions, or in whom the mala-

rial cachexia is present, and constitutes one of the manifestations of this disorder. In these cases the remedies which are applicable to the treatment of the malarial complication, will often be sufficient to eradicate the neuralgia.

In many instances, acute disturbance of the dental organs is occasioned by a neurosis originating in the ear and affecting the parts to which the fibres of the fifth nerve are distributed, by what is called "reflex action," and this variety of the disease is distinguished by the term "reflex neurosis." The irritation which exists in one part is transmitted to the area of some other nervous distribution, and there awakens the symptoms of functional disease of those nervous trunks. At times the distress occasioned by a reflex neurosis is so acute that the most radical measures of treatment are eagerly sought by the patient, in order to obtain relief from the agonizing pain. In one case known to the writer, a severe neuralgia was developed in a case of fracture of the arm. The patient was a soldier, who had been much reduced in health by the hardships of army life, and by dissipation. The neurosis proved to be so refractory that the patient at last was subjected to amputation of the right arm above the elbow, in the hope of obtaining relief. This proved unavailing, and the arm was twice afterward reamputated, the last operation being accompanied by the removal of the entire remaining portion of the arm at the shoulder joint; but all was of no avail, and the patient is still suffering from a painful neurosis for which no further operative treatment is available, and which has obstinately

resisted all known measures for the relief of neuralgic distress. In the jaw and teeth the existence of pain from reflex sources is sometimes so severe as to call for energetic measures for its relief, as it constitutes an agony so great that the patient cannot endure it. For this object, various operations upon the superior and inferior dental nerve have been suggested and performed. Among these are the removal of a portion of the body of the inferior maxillary bone at a point behind the wisdom tooth, near the angle of the jaw, by which the inferior dental canal is exposed, and the excision of a portion of the inferior maxillary nerve by means of scissors. This operation is sometimes followed by entire relief from the distress, but unfortunately, in no small number of instances, the relief is only of temporary nature, and the original distress returns after a longer or shorter period in all its former intensity.

Various neuroses of neuralgic character are due to disturbances of the nutrition, and seem to depend upon a deterioration of the standard of health in the individual, from causes affecting the general condition. These affections may betray themselves in many ways, but quite frequently are manifested by functional disturbances of sensation; and often there is pain in the area of the superficial nervous distribution, due apparently to the influence of external surroundings upon the trunk of the nerve, or upon its terminal fibres. Occasionally great local distress is caused in remote parts of the body by the presence and increase in size of a tumor, or some other pathological process in the brain, by

which pressure is exerted upon the nerve trunks either at the point where they pass out through the skull, or upon some portion of their course within the cerebral structures. This constitutes a very serious condition, and there is little to be hoped from any form of medicinal treatment, except in those cases in which this manifestation may be due to syphilis, in which cases the administration of iodide of potassium in large doses may at times afford relief. In rare instances, when the seat of the trouble in the brain can be accurately located, the operation of trephining the skull might become a justifiable procedure.

PART V.

CHAPTER XXIV.

INFLAMMATION.

By the term "inflammation" is meant the occurrence of a series of phenomena which are associated with certain changes in the condition of the animal tissues, and which have, as the result of their action, a more or less extensive change in the temporary condition of the parts affected; with the subsequent restoration of the structures to their original condition; or the result may be a permanent change in the condition of certain parts, or entire organs.

The four principal phenomena associated with the existence of inflammation are the following: the Hyperæmia; the Exudation, with or without the formation of pus; the Proliferation of Tissue, and the subsequent changes or degeneration of these new-formed tissues.

These features are always present in any inflammation of a serious character, though they may not be evident in an inflammatory process of small intensity, in which the whole process is of short duration. They are most plainly observed in such inflammations as run a rapid and violent course, the so-called "acute" inflammations, and which terminate either

by the process of spontaneous subsidence, or by the subsequent occurrence of suppuration or of gangrene.

The inflammatory action is induced as the effect of some irritant, or from some injury to the parts which are the seat of the inflammation; or it may be due to some interference with the blood supply of the organ or part affected; or with the nerves which ramify in the part.

The first feature of an inflammation is the local Hyperæmia of the part. This is produced by the increased amount of blood in the vessels of the part in which the inflammatory process is seated. Simple hyperæmia in itself, however, does not constitute inflammation, but in inflammation there is always hyperæmia.

The second feature of the inflammatory process is the Exudation into the part, and the occurrence of Suppuration, if the inflammation should extend to this degree. The exudation is the most important of all the phenomena of inflammation. It may occur in three forms, according to its location in the body: it may exist as a free accumulation of inflammatory products in any of the cavities of the body; or it may be contained within the organs of a part, as the muscles, in the connective tissue, in the glandular structures, etc., or, finally, it may occur in the shape of an extensive infiltration into the tissues of the body, where it operates by pushing the natural structures apart and filling a larger or smaller space in the part which was previously occupied by these structures.

The third feature of inflammation is the formation

of new tissues, or the hypertrophy, *i. e.*, the enlargement or the thickening of the natural tissues of the part. One form of new growth in inflammatory processes is the adhesion of adjacent parts or organs to one another. This is seen particularly in the inflammation of the serous membranes, in which there is almost invariably a union of the surfaces one to the other, which is then a permanent condition. The cavity of the serous membranes becomes obliterated, and the surfaces are grown together.

The retrogression, or the removal of the exudation, is the fourth and last feature of the inflammatory process. This may take place in the way of gradual absorption of the exudative material, or it may take the form of the death of the tissue, as in gangrene, or in extensive abscesses in the tissues involved.

The course of an inflammation is accompanied by four principal indications, by which the existence of the inflammatory process, and the degree of its intensity may be determined, and which may be regarded as the *cardinal symptoms* of inflammation. They are the following: Pain; Heat; Redness, and Swelling, to which may appropriately be added a fifth, namely, suspension, or at least disturbance of function. The first four of these symptoms correspond to the old formula for inflammatory action, viz., Rubor, Calor, Tumor, Dolor, and are all present to a greater or less degree of intensity in any inflammatory process. At times the interference with the health and comfort of the patient may be so slight that the symptoms of a trivial inflammation may not become apparent to observation, or indeed be

noticed by the patient, but careful examination of the part affected will always afford evidence of the existence of the conditions mentioned above.

The invariable and universal origin of any inflammatory process consists in some insult or injury by which the tissues were primarily affected; or in the action of some irritant of mechanical or chemical character; or in some interference with the normal and healthy nutrition of the part, as would be caused by any disturbance of the normal blood supply; or, lastly, with the distribution of the nervous influence in the portion of the body which is the seat of the inflammatory affection. Thus the cause of an inflammation of the surface of the body may have been the action of a high temperature, by which a burn has been produced, which is then the origin of an inflammatory process, which usually results in the healing of the part injured. Again, a part of the body may be subjected to pressure, by which its texture is crushed or bruised, and there we see the cause for inflammatory action in the injury resulting from the destruction of the normal constitution and relations of the tissues. Again, the freezing of the flesh by exposure to extreme cold may occasion a series of inflammatory changes, accompanying the effort of nature to remove the dead and useless portion, the vitality of which was destroyed by freezing, from the adjacent part which was not affected to an extent sufficient to destroy its vitality.

Any interference with the integrity of the parts or tissues of the body, or of any part of it, by operations of a surgical nature, would also give rise to a

greater or less degree of inflammatory action. So that we must regard the cause of inflammation in any part or under any circumstances, as due to some disturbance of the ordinary and normal condition of the part, from unnatural and external, or at least abnormal causes or influences.

The first visible symptom of inflammation consists in an increased redness of the part which is the seat of the injury, of whatever kind this may have been; or in some cases the redness may be located not at the seat of the inflammation, but at a little distance from it. The latter condition is noticed in the commencement of an inflammation of the cornea, when the redness is not located upon the cornea itself, but is confined to the conjunctival mucous membrane; from which it later may extend on to the cornea, until it reaches the seat of the original injury which caused the inflammation. A similar condition is observed in inflammatory conditions affecting cartilaginous structures, when the redness is located in the adjacent tissues, and not in the cartilage itself, which possesses no blood vessels, and cannot therefore show redness as a sign of inflammation, at the same time that this would be observed in the vascular tissues.

The redness of the part which is the seat of a commencing inflammation is due to the fact that the vessels of the part which is the seat of the insult, and in which the inflammation is developing, are temporarily paralyzed, and they therefore dilate, and allow a greater amount of blood to enter their channels than can take place in a natural condition. The first

action of any injury, therefore, is to cause a temporary paralysis of the muscular fibres in the wall of the blood vessels of the part exposed to the injury, and thereby allow an increased amount of blood to enter the vessels, and thus give a heightened color to the flesh, which color is recognized as one of the symptoms of a commencing inflammation, and is the first appearance noticeable to the eye.

The second of the cardinal symptoms of inflammation consists in the elevation of the temperature of the part in which the inflammation is located. This phenomenon is intimately associated with the preceding one, and depends in a great measure upon it. The temperature of the interior of the body is always higher than is shown by the thermometer applied upon the outside of the body, which is cooler, owing to the loss of heat by radiation. The blood, therefore, in the heart and other large organs of the body is warmer than it is when it has reached the extremities, and has thus become somewhat cooled. If, now, the vessels of the extremities were enlarged, so as to allow a larger amount of blood to pass through them, the temperature of the part would be elevated, from the larger amount of warmer blood coursing through the vessels of the part. Thus we find the reason for a portion of the heat which is noticed in any part of the body which is the seat of acute inflammation. In some forms of disease, particularly those of an infectious character, as in typhoid fever, the temperature of the entire body is much higher than normal, and the patient is said to have a "general" fever in distinction from a local eleva-

tion of the temperature in a particular portion of the body, due to some inflammatory action confined to this one part.

The third of the phenomena attending inflammation is the swelling. This is due to two causes, viz., the hyperæmia, or increased amount of blood in the part, and also to the leaking of the fluid part of the blood through the walls of the blood vessels into the tissues of the part affected, which is called the "effusion" of serum; and this adds to the size of the organ or portion of the tissues which is the seat of the inflammation; and from these two different sources the main portion of the swelling, sometimes very great in amount, is derived.

The fourth of the symptoms of inflammation, the pain, is the result of the previous phenomena. It is produced by increase of pressure in the part in which the inflammation is seated; and results at times from a moderate amount of pressure, as in toothache, which is the result of increased pressure in the interior of the tooth chamber, or at its root, which are both inclosed in unyielding walls, so that no expansion can take place, and the result is an immediate and painful pressure by the effusion or swelling upon the nerves of the tissues thus inclosed; and the fourth symptom of inflammation, the pain, is thus produced. In some parts of the body in which the tissues are loose and yielding, as in the eyelid, the swelling may be very great in amount without causing pain, because the tissues are able to stretch and to accommodate the fluid without sufficient pressure to cause pain. The same amount of effusion in the

end of the finger, as in felon, would cause intolerable agony. The pain is actually caused by compression of the sensitive nerves of the part, and is more or less intense according as the effusion is more or less confined, and is, therefore, the cause of greater compression of the nerves which lie in the tissues of the inflamed area.

To the symptoms of inflammation thus far enumerated may properly be added one other—the suspension of function of the part affected. If the eye is the seat of inflammation, it becomes so sensitive to light that it cannot be used for seeing anything; if the tooth be inflamed, it is quite impossible to bite upon it on account of the pain which would thereby be caused; and if the finger be the seat of acute inflammation, it becomes painfully sensitive to the slightest touch. Thus we find that the function of the part inflamed is always seriously interfered with, and generally entirely suspended during the existence of the inflammation.

The particular features of the inflammatory process have long been the object of careful study by many pathologists; but it remained for the late Prof. Cohnheim to discover the essential character of this most interesting condition.

After long and diligent investigation, Prof. Cohnheim was able to lay before the profession the tangible and visible features accompanying the symptoms of the inflammatory process, and to explain the heretofore unknown causes of these features. By the use of the microscope, he was able, after repeated trials upon rabbits and guinea pigs, to observe the changes

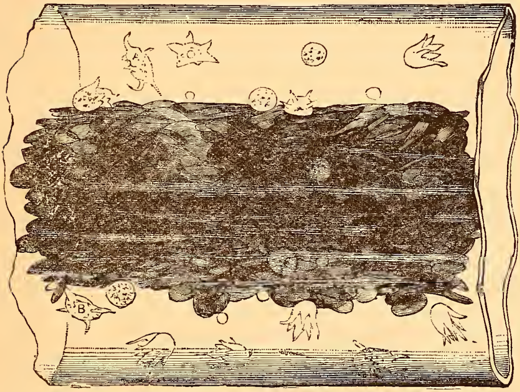
in the tissues, which had been so treated as to cause inflammation of these parts. The frog was finally found to be the most useful subject for experimentation, and was the animal usually chosen for demonstration. If the tongue of a frog be extended upon a glass slide, and be fastened there by means of small pins, so as to keep it spread out in a thin layer (the frog being under the influence of curare), the passage of the blood in the vessels of the tongue, both in the veins and in the arteries, may be observed with the greatest distinctness through the tissues of the uninjured organ. The parts will be seen in a state of perfect health. If, now, a portion of the mucous membrane be removed by a fine scissors, and thus a wound of the surface of the tongue be produced, we shall at once have a condition of commencing inflammation, and shall be able to follow the changes thus inaugurated throughout their course, without the slightest trouble. The tongue should be kept wet with a solution of chloride of sodium, in order that the organ may not become too dry in the long exposure to which it is subjected, and thus the processes going on be either hindered or rendered inactive.

The first change noticeable to the eye on removing the mucous membrane as has been described above, is that the incision gaps to a size larger than the piece of mucous membrane removed would seem to allow; that is, that there is active contraction in the wounded edges, so that the wound is made larger by the retraction of the border of the incision. This indicates that there is an active irritation at the seat of the lesion, which awakens an immediate response

in the way of positive contraction of the wounded tissues. Soon the blood vessels in the area of the wound are seen to present marked changes in their appearance. These changes are first noticeable in the veins, and consist in a distinct enlargement of their calibre, by which they become great trunks, in which the current of the blood is slowed, on account of the larger size of the channel, and in which it comes at times to remain absolutely quiet. Usually, however, there is a continuous, though it may be a very moderate, movement in the blood current, so that it is not stopped in its flow. With the enlargement of the channel and the slowing of the current, there is associated a change in the composition of the current. In the ordinary flow of the blood there is no separation of the elements of the blood; the stream is homogeneous. Now, however, there is soon observed to be a change in the composition of the blood current. There is a separation of the blood, so that the white corpuscles come to lie against the wall of the blood vessel, while the red corpuscles pass along the middle of the vessel, and constitute the bulk of the moving current, the white corpuscles remaining comparatively stationary. At length there is a tendency among the white corpuscles to stick to one place upon the wall of the vessel, and no movement of the blood current is sufficient to remove them. Soon a portion of the white cell is seen to appear upon the *outside* of the wall of the blood vessel, and by a slow process this portion increases in size, while the part still within the blood vessel becomes smaller, until the entire corpuscle has passed

through the wall of the blood vessel, and is seen to lie in the connective tissue upon the outside, having migrated through the vascular wall, without leaving any visible orifice where it passed through. From this point the white blood cell now migrates still

Fig. 31.



Cut showing the effect of a commencing inflammation upon the blood-current of the part The red corpuscles are collected in a central column in the middle of the vessel, while the white corpuscles tend to approach the wall of the vessel, and in some places are adherent to it, and have already begun to throw out fantastic prolongations like the petals of a lily, or irregular elongations which indicate the commencement of migratory movements. At *A* and *B* the cells have penetrated the wall of the channel, and are on the outside of the vessel, and moving away into the tissues. The cut represents the blood of the frog, but can only faintly indicate the beauty of the process of cell-migration as seen under the microscope.

further in the tissue toward a free surface; and at length appears upon the wounded surface, from which it may be removed by gently touching it with a camel's-hair pencil: and the blood cell which was a

short time before in the veins of the animal, is free, and outside of the body of the animal.

In an extensive inflammation the process here described is carried on to a surprising degree, and the number of cells thus passing away is very large, so that a considerable discharge of yellowish creamy substance takes place from the seat of the injury, which is called "pus." Thus, we see that so-called "pus" is due, in great part, to the exudation or migration of white blood cells from the inside of the blood vessels, through their uninjured walls, and thence to the surface of the inflamed spot, where these same cells are discharged as a fluid, which has long been recognized, but the composition of which was not distinctly understood. There are, also, other components of pus, but the essential elements are the serum which is exuded from the tissues, and the white cells of the blood, which are due to the migration of the corpuscles through the walls of the vascular channels. Here we find the reason for the increase in the swelling accompanying an acute inflammation which has lasted for some hours or days, in which the processes of exudation of serum and the migration of the white corpuscles has been going on actively, until the entire tissue of the part is filled with these products of migratory action, and the mass of the part is much increased in volume; so that there is a large and hard spot at the seat of the inflammation, which is called the inflammatory "induration." The irritation of the inflammatory process also causes increased growth in the natural tissues of the part affected, and the entire organ may thus be enlarged, as is seen in an

old and long-standing abscess of the jaw, in which the entire bone of the jaw has become thickened, and is found to present a large and hard lump at the site of the disease; which often subsides only very slowly, if it is ever wholly removed.

The occurrence of suppuration, as has just been shown, is accompanied by the passage of large numbers of white blood cells from the interior of the blood vessels into the tissues, and thence to the surface, which has either been injured, or in some way has become the seat of inflammatory action. There are, however, other elements associated with suppuration, which arise in part from the intensity of the disturbance in the region of the inflammation, but are also in part accidental. Those which are due to the disturbances of the part are of the nature of destruction of portions of the normal tissues of the region, and are caused, to a great extent, by the unusual pressure which exists as one of the consequences of the inflammation. Destruction of tissue may also be produced by disturbance of the blood supply, by which the nutrition of the part may be seriously impaired, and loss of vitality, or gangrene be thereby induced. The products of disorganization of the tissues from any cause are thrown off from the body as rapidly as possible, and if suppuration already exists in the vicinity, they generally find their way into the discharge, and are thus mixed with the pus. Portions of muscular fibre, particles of connective tissue and other structures are, in this way, often associated with a purulent discharge, although they properly form no part of the pus, strictly speaking.

To these constituents of the discharge from an inflamed part are to be added accidental admixtures from external sources, such as the various forms of bacteria, the coloring matters sometimes found in pus, and the other foreign substances occasionally observed in the vicinity of suppurating wounds. These various admixtures are mentioned in this connection because they are often observed in relation to wounds, especially when these are not in a cleanly or healthy condition, and sometimes the contaminations of pus are the most important factors in the progress of the lesion toward recovery, or toward further destruction of the tissues and the extension of the disease.

We have thus far considered inflammation only in relation to those parts in which there is an abundant and continuous blood supply. It might be thought that the phenomena of inflammation would be different in those parts in which the blood supply either is limited in amount, or in which there is no vascular circulation. The latter is true in the cornea, which is a transparent structure, entirely without blood vessels, when in a condition of health. If now the centre of the cornea becomes the seat of an injury, causing inflammation, there will be a variation from the series of symptoms detailed above, to correspond with the changed conditions in the normal structure of the tissue affected.

The cornea being without blood vessels, it is plain that there could be no immediate dilatation of blood vessels in the area of the injury. Experiments, however, have proved that the general outline of inflam-

mation in the corneal tissues is the same as that in other and vascular structures. If the centre of the cornea be touched with a heated needle (and this is the best way of inducing a traumatic inflammation, for several reasons), there is no reaction at the immediate seat of the injury; there is pain, because the sensitive nerves of the cornea have been cauterized, and the structure of the cornea is destroyed to a certain degree. The symptoms of inflammatory reaction, however, are observed at the *edge* of the cornea, at that point which is nearest to the seat of the injury; at which point there is observed, almost immediately, an enlargement of those blood vessels which were before visible, together with the appearance of numerous other vessels which were not before to be seen. At once there is a stagnation of the blood in these large vessels, the migration of the white blood cells begins, there is swelling of the conjunctiva, and the signs of an intense activity of the inflammatory action. Soon a wedge-shaped point of grayish opaque character appears at the edge of the cornea nearest the injury and slowly advances toward the point at which the injury was inflicted, and when, after some hours, it has reached the seat of the injury, it comes to the surface, and is seen to be composed of white cells of the blood, consequently *pus*, which has been conveyed from the nearest point at which blood vessels are distributed, and has appeared at the distant seat of injury in the cornea. Soon after this time, fine blood vessels are seen to extend on to the cornea, and finally to reach the point of injury, when the process of migration of white cells goes on even

more rapidly than before. Thus we see that in an acute inflammation there is a formation of not only additional substance in the part affected; but in the eye at least, there is a production of new organic structures in a part in which no such structures normally belong. When the process of healing has been completed, these new vessels disappear, and when the eye is at length well, no trace of these vessels can be detected. In the structure of cartilage, again, there is no normal blood circulation, but in inflammation of this structure there is a prolongation of the vascular supply from the nearest point, so that at length the seat of inflammation is found to possess a vascular network, and to be supplied with blood.

CHAPTER XXV.

COURSE AND PROGRESS OF SYMPTOMS IN ACUTE INFLAMMATION.

The cause of the successive phenomena attending inflammation has long been a subject of speculation, but the most recent investigations seem to point to the following explanation : At the time of the injury, there is a shock of greater or less intensity to the nervous structures supplying the part affected. The first intensity of the injury and its first effect is developed in the nerves of the part, which are, for the time, deprived of their activity, and lose their function. This is especially applicable to the nerves distributed to the vessels, the so-called vaso-motor nerves, which control the degree of contraction of the muscular fibres of the coats of the blood vessels, and thus regulate their calibre. The effect of the temporary paralysis of these muscular fibres is the immediate dilatation of the vessels to their fullest capacity, and thus they receive a much larger amount of blood than under ordinary circumstances, and mark the redness of commencing inflammation.

The pressure of the blood within the walls of the vessels is notably increased under this condition, from the fact that the larger calibre of the vessel in the area of the inflammation is the cause of increased internal pressure, from the same cause as operates in the hydrostatic pump, that is, that the passage of the

current of blood from a smaller channel into a larger one is accompanied by an increase of tension in the walls of the larger vessel. The dilatation of the lumen of the vessel must be accompanied by a diminution in the thickness of its wall, as the tissues of the vascular wall are spread over a larger surface, and thus the actual resistance to the passage of fluids out of the vessel is notably diminished. This fact may also have something to do with the migration of the white blood cells, but this is not proven, as the passage of these bodies through the wall of the blood vessels seems to be an organic activity, and not the result of a variation in the mechanical resistance of the tissues. This entire subject is not yet satisfactorily decided, but many features still remain for elucidation by future observers. In dental pathology there is especially a field for clinical and experimental work, in the investigation of inflammatory and other diseased and destructive processes.

The cause of inflammation is not always the same, for the conditions under which it arises are variable, and the locations of origin are widely different. In the description above given, the cause of the inflammation was supposed to be an external injury. This is, however, but one of the occasions under which inflammatory conditions may arise. A more frequent cause, at least in the region of the mouth and teeth, is found in the disturbance of the nutrition of the part or organ, by some interference with its blood supply, the stoppage of which causes the death of the part from which the blood is cut off. This accident produces a condition in some ways the oppo-

site of that which was described above. There is in this case a portion of tissue in the interior of some organ which has lost its vitality from lack of nutrition, and is transformed into a larger or smaller mass of dead tissue; which is now only a foreign body, for which the system has no use, and which nature immediately endeavors to cast out of the system. The seat of irritation is not situated upon a free surface, but is located in the midst of healthy or, at least, vitalized, tissues. This form of inflammation may be illustrated by the history of a common felon upon the end of the finger, which corresponds in all essential conditions to an acute inflammation situated in any other resisting portion of the system. In felon, the inflammation commences by a slight sensation of pain in the end of the finger, which is, ordinarily, so indistinct that its exact location cannot be recognized, but the sensation is one of ill-defined pain and tenderness. Soon the pain becomes more pronounced, and at length the agony is something beyond description. If no treatment is instituted, the finger is finally much swollen and breaks at some part of its surface, discharging a large amount of pus and broken-down tissues, together with a portion or the whole of the bone of that phalanx of the finger; or the inflammation may follow the course of the tendons up the finger, into the hand, or even to the forearm, which then becomes the seat of extensive suppuration, causing large abscesses, which sometimes render amputation of the arm necessary, or even destroy the life of the patient. In a felon, the seat of the primary irritation, the insult, the first

cause of the inflammation, is located in the deep part of the finger, often in the sheath of the tendon or in the periosteum covering the bone. The phenomena of commencing inflammation occur in the same way here as when the seat of the injury is located upon the outside of the body, but the parts are firmly bound down by strong membranes which do not allow any distention of the tissues to accommodate the increased amount of blood, serum, etc., which crowd into the inflamed part. The consequence of this is, that the effusion of serum, white corpuscles, etc., is the cause of enormous pressure upon the parts around, the nerves of the tissues are greatly compressed and the pain is intense. The pressure also closes some of the blood vessels of the neighborhood by pressing their sides together, and this also interferes with the nutrition of some portion of the tissue near the seat of the inflammation. The result of all this is, that in the deep parts of the finger there is a fragment of flesh which has been deprived of its vitality, and has undergone a process of disintegration called Necrosis. The flesh may be quite dissolved, or it may be found as a ragged mass of grayish color and shreddy appearance, which is found at the bottom of the wound if the felon be opened in due time, or is cast out at the opening which occurs after a longer time, if the finger be left alone. This shred of dead tissue is recognized as the *slough*, or a portion of the finger which has died from lack of nutrition, and is called by the common people the "core." An abscess is not thought by the laity to be in condition to heal until

the " core " is discharged, when it is rightly supposed that the cause of the inflammation has been removed and healing of the part may occur.

There is, therefore, an additional feature in the history of deep-seated inflammations, consisting in the existence of a centre of irritation which is formed in some part of the normal tissues of the organ, either of the hard or the soft structures; which is devitalized from some cause, and is thereby transformed into a source of inflammation, has become a foreign body, which nature cannot use, but tries to remove from the body, as would be the case were a splinter of wood or a fragment of iron to be lodged in the body. When the slough is at length gotten rid of, the process of recovery may commence, and the part may at length be restored to its original condition; or the amount of damage caused by the inflammation may have been so great that perfect restoration may not be possible, and a greater or less degree of deformity remains after healing is complete. Frequently there is a mark at the seat of the inflammation, which is of different color from the surrounding skin, and is called the *scar*. This may, after a time, become invisible, but frequently it remains as a permanent condition during the life of the individual.

CHAPTER XXVI.

INFLAMMATION OF HARD STRUCTURES AND OF THE TEETH.

The inflammatory process is not always confined to the soft tissues, but may extend to the hard structures, such as the bones and teeth. Here it is not the calcareous portion of the bony material which is affected, but it is the soft connective tissue which penetrates every part of the bone, which is the actual seat of the inflammation; or it may be that the periosteum which covers the bone on its outer surface is the part which is affected. However this may be, the inflammation generally extends into the bone itself to a greater or less degree, and by the pressure and other phenomena above explained, causes the death of a part of the bone, with its contained connective tissue, vessels, etc. This forms a foreign body, just as in the inflammation of the soft tissues, we find a slough. The portion of bone which is deprived of its nutrition might be called a slough of bone, but the common name given to such a portion of one of the bones is that of Necrosis. Necrosis means really nothing but "dead tissue," and thus far the name is not well chosen, but it has become familiar to dentists in relation to dead *bone*, rather than the same condition in the soft tissues, until it is now frequently understood to refer only to the hard tissues. In inflammation of the bony structures, the same

process is at once started, as is the case in the soft parts, in the way of dilatation of the blood vessels, exudation of serum, the migration of the white blood cells, and the obstruction of the circulation. The portion of the bone which has become necrosed is slowly separated from the living tissue around it, and is at length cast off from the healthy portion; when healing of the part may take place, as in those cases in which the inflammation affects the soft tissues. When the inflammation is seated in bone, the processes of separation and repair are much more slowly carried out than in the soft parts, owing to the dense character of the structures involved, but the process is of exactly the same character as in the soft tissues. When the bone has become separated from its attachment to the surrounding parts, it is often retained in place, from the fact that its size and firm structure prevent it from being so easily thrown out of the system as the soft slough of an ordinary abscess may be. We, therefore, find the portion of bone in many cases lying loose in the cavity of the abscess, where it is being slowly disintegrated by the action of the tissues around it, until it becomes so broken up that the particles may pass through the channel made by the escape of the pus, when, after all the portions of bone have been extruded, the place may heal entirely. The loose portion of bone in these cases of necrosis is called a *sequestrum*. In some cases it may be only a small part of one of the bones of the finger, or it may comprise the entire shaft of one of the long bones of the limbs. This affection is frequently observed in the region of the teeth, in the alveolar

process of the upper or lower jaw, in the vicinity of the antrum, or it may be situated upon the inferior surface of the hard palate, from which situation it may extend over a large portion of the roof of the mouth. In these various locations the necrosis may be due to very different causes, among which may be mentioned caries of the teeth, inducing destruction of the neighboring alveolar process; injury, such as fracture of the jaw; the effect of certain poisons, particularly phosphorus; the result of some of the constitutional diseases, among which may be prominently mentioned syphilis; the invasion of the parts by cancerous or other malignant growths, and the occasional result of the presence of lead or mercury in the system.

From whatever cause the necrosis may have been produced, the conditions in the part affected are almost always similar. The dead portion of bone is at first retained in the location where it was formed; a swelling of the soft parts covering the seat of the disease takes place, and the formation of pus occurs in the way above described. After a time the membrane, or, if on the outer surface of the body, the skin becomes distended and thinned, and at length an opening is formed through which the accumulated matter escapes. At the bottom of the opening thus formed, we may feel the denuded surface of the dead but still immovable bone, as a rough and grating surface, from which the periosteum is absent, and which is bathed in the purulent fluid which is discharged from the wound.

The examination of a part which is the seat of

disease, to ascertain if necrosis exists, is not always easy, on account of the fact that the channel leading down to the necrosed bone is often of a winding or devious character and cannot be easily followed. For the purpose of such an examination, the best means is by a long and slender probe, with which we gently penetrate the canal, and by curving the probe, follow the curves of the passage until we reach the portion of bone at its deepest part. The probe should be held very lightly by the fingers, and should be manipulated with the utmost care and gentleness; it should, in reality, form only a prolongation of the fingers, and should serve to convey an exact idea of the nature and character of the tissues with which it is in contact at any part of its course. The impression made by the impact of the end of the probe with denuded bone is a peculiar one, and one not easy to describe by words. It is not always the same, but is different, according to the character of the bone affected, whether this be of dense or loose structure, and also, to a certain extent, varying in correspondence to the time during which the necrosis has existed.

The presence of an inflammation in the near vicinity of a bone is not always followed by necrosis, but may sometimes give rise to increased growth of the tissues in the vicinity of the bone, which increase in growth usually affects the fibrous structures, such as the periosteum or the connective tissues; so that a thickening of these structures takes place and their volume is materially increased by the new formation which thus follows, as a consequence of the irritation

caused by the proximity of the inflammation. This effect is often observed in the vicinity of a chronic inflammation of the alveolus; as well as in some cases of slow and prolonged inflammation of the root of a tooth, in which the activity of the inflammatory process is not sufficiently marked to produce the phenomena of acute inflammation of the alveolus; but the whole process is very slow and gradual, and requires weeks or months for its course. At the end of this time we may often feel an enlargement of the bone at, or over the seat of the inflammation, where there is an actual increase in the thickness of the bone or of the periosteal covering, due to irritation from the inflammatory process which has been carried on near it. This increase in the size of the bony tissue when it is permanent is called an "exostosis" or a "hyperostosis" upon the surface of the bone; and when it affects the soft tissues it is usually called a "hypertrophy" of these tissues. The word "hypertrophy" means simply an overgrowth of any of the tissues of the body, but it is generally understood to apply particularly to the soft tissues, while the terms "exostosis" and "hyperostosis," relating to bone, apply only to the hard tissues. The same general process of increased growth here described, takes place in the healing of a fractured bone, during which there is a large amount of extra material thrown out about the point of injury, which envelops the seat of the fracture, covering the ends of the broken bone, and thus uniting them by an external growth of new tissue about the seat of the injury, much in the way

in which a plumber unites the ends of lead pipes by placing a large elongated fusiform mass of lead around the ends, which unites them in a perfect joint. After the broken bone has fully healed, the mass of callus, as the extra material which is thrown out at the ends of the broken bone is called, and which first unites the fracture with a mass of soft substance much as putty would unite a rod of glass which had been broken, which, in fracture, forms the first means of union between the ends of the fractured bone, is gradually absorbed and carried away; so that after a time there is no trace of this substance to be found at the place where the bone had been broken. Nature removes the extra material as soon as there is no further need of it, and the parts are restored to their former condition. In the case of new formation of bone, however, as the result of a long-standing irritation, there is no such prompt effort at removal of the new formation, but the mass of extra material is permanent, and remains so during the lifetime of the patient. As a result of this, we often see nodules of new bone attached to many of the bones of the body, which have been formed by the action of some inflammatory process and have never changed afterward. This is frequently remarked upon teeth which have been the seat of pain or other signs of subacute inflammation at a period long anterior to their extraction, and which, on being removed from the jaw, show large club-shaped protuberances from the root surface; or the entire root may have been changed into a thick and knobbed mass of bony tissue, in which all resemblance to the

normal shape of the root of the tooth is utterly lost. At times the existence of a long-continued, low, subacute form of inflammation in the vicinity of the root of a tooth will cause the formation of an enlargement upon the outer surface of the jaw, which will persist through the life of the individual, though it may, in some cases, be somewhat reduced in size as time passes. In other cases, the irritation or other causative agent may be confined in its action to a limited area situated upon a circumscribed portion of the root of a tooth, or other portion of the dental apparatus, when the effect will be observed in the way of an hypertrophy or increase in the size of the part which was the seat of the irritative process. This often produces the strangest results in the way of deviations in the shape of the teeth or of some portion of their structure, at times causing a deformity in their roots, in other cases causing a malformation in some of the other features of the tooth structure, which may remain unchanged for any length of time after it has once been produced.

Thus the results of inflammatory action may vary according as the inflammation is of acute and violent character, or is of a more moderate degree of intensity and progresses more slowly. The first is usually followed by a sudden interference with the integrity of the tissues of the part which is the seat of the inflammation, and with a serious disturbance of its nutrition; both of which operate to the detriment of the tissues, and lead to their serious impairment; and not infrequently to their destruction, by the processes of necrosis, suppuration and ulceration, with loss of a

certain amount of the normal material of the part. This may be more or less completely restored by the processes of repair which are associated with the healing of these lesions in many parts of the body. Recovery is often unaccompanied by any of the signs of destruction of the tissues, but, on the contrary, the inflammatory process has the power to awaken new and unusual growth in the tissues affected, by which their volume is augmented and their character often changed, as when the tissues are rendered brawny and thickened. In a chronic alveolar abscess, the thickness of the alveolus may be greatly augmented as the result of the irritation of the periosteum and other adjacent tissues, by which increased growth of these structures and an increased amount of their products is produced. In any study of these processes it is essential to remember that the irritation of a certain tissue is not necessarily followed by an increase in volume of that particular tissue, but that the increase may, perhaps, be in the substance of some other tissue or structure. Thus, the irritation of the periosteum, when this is not of too acute form, has for its principal result, not an augmentation of the periosteum but the deposition of increased amount of bone, so that a bony tumor is at length formed, of greater or less extent, either in the shape of a considerable enlargement at a circumscribed part, or it may be in the form of an extended fusiform increase in size of the part which was the actual seat of the inflammatory process, and of the adjacent bony texture as well. The increase in the contour of the jaw from hypertrophy may be

followed by an absorption of the bony tissue in some other part of the jaw, and a change in the bone may thus be brought about which will at length greatly alter the appearance of the facial outlines, and be the cause of actual deformity to the individual. This gradual transformation is sometimes productive of change in the location or the direction of the teeth, which may become extruded and lost, from absorption of the bone about their roots, and in this way the changes in the nutrition of the bone, which were brought forth by the inflammatory process may produce a lasting detrimental effect upon the denture of the individual. The hyperplasia of bony tissues may have still another effect upon the nutritive changes in the part, from the fact that the new formation of bone often takes place in or around the channels in which the blood vessels and nerves of the bones are contained. Any new deposition of bone within the canal which contains such an important structure as an artery, a vein or a nerve must seriously interfere with the function of these organs in the way of a greater or less disturbance of the circulation, or the nervous supply in that part to which the blood vessels or nerves are directed. This may be so serious in degree that the integrity of the part is affected, and the organ which is thus deprived of some portion of its nutritive supply may undergo a gradual retrogressive change, called atrophy, in which the tissues, especially the soft tissues, become diminished in volume, weakened in structure, reduced in texture and enfeebled in function; and may at length entirely disappear, from the absorption of the atro-

phied and degenerated remains of the former structures, which have been deprived of their proper nutrition by the partial closure of the channels of their blood supply or of their nervous distribution, from interior exostoses.

Far more frequently than the degeneration of the tissues, as the result of exostosis, is the occurrence of pain in the parts to which the nerve which passes through the canal is directed. The pressure upon the nerve trunk causes a sensation of pain in those parts in which it is distributed, and the pain is often of most acute character, being one of the well-recognized forms of neuralgia, or pain in the nerve. With this, there may be no atrophy, and it is a fact that most acute suffering from neuralgic pain may often be endured a long time without perceptible effect upon the volume of the tissues or upon their functional integrity, their only impairment being such as may be due to the interference with their proper functions which is occasioned by the excessive pain.

Occasionally the progress of a chronic inflammation is accompanied by the formation of an abscess, situated at or near the seat of the original inflammation and due to it. The abscess is filled with a purulent fluid, the character of which does not materially differ from that found in an acute abscess, such as is described in a previous chapter, except that the suppuration which occurs as the result of a chronic abscess is noticeably more consistent than that from an acute abscess; that is, the pus in an acute and rapidly-formed abscess contains more fluid than that in a chronic abscess. There is also less febrile action,

less heat of the surface, less reaction in any way, and the entire process is less energetic and less vivid in all respects. On this account, this variety of inflammation, with its following abscess, has given rise to the designation of the process as a "cold abscess." The processes in this variety of abscess are doubtless of the same degree of severity as in a so-called "acute" abscess, but being distributed over a longer period of time, they at no time present the same degree of violence as do the symptoms of an acute inflammation.

One of the results of chronic inflammation may be the slow formation of deposits of purulent fluid, which may remain for a long time in a quiescent state, and may never come to the surface so as to be discharged, but are retained in the tissues where first deposited, giving no indications of trouble from their presence. The pus thus imprisoned gradually loses much of its fluid portions, and at length is reduced to a cheesy mass, which may at times contain small lumps of calcareous material, and then is called cheesy pus, or calcified pus. Such deposits, or the remains of former inflammations, are often found in post-mortem examinations of persons who have died from the most various causes, but who at some former time may have suffered from a slow and lingering inflammation, which had led to a formation of pus, which then underwent the process of thickening as above described, with the result that the cheesy residue of the suppuration had been retained for a long period within the system of the patient, where it did no further harm. Such deposits may be observed in the lungs, in the neighborhood of the lymphatic

glands, and frequently in other not so common situations. It was at one time thought that the presence of inspissated or cheesy pus in the body was a predisposing cause of tuberculosis, but this theory is no longer maintained by the most able pathologists; and tuberculosis is now believed to depend upon the presence in the body of a certain bacterial organism, the bacillus tuberculosis, which has no constant or definite relation with purulent deposits as causative factors in their existence, or their appearance in any case of that disease.

PART VI.

CHAPTER XXVII.

PATHOLOGICAL AND MALIGNANT GROWTHS (TUMORS).

Among the conditions associated with the pathology of the oral cavity and its surroundings, none are more interesting than those relating to the new formations which are observed there. These may be of two general varieties, the benignant or harmless growths, and the malignant or destructive growths. In general terms, any enlargement of a part, if it be of a circumscribed character, and particularly if it be elevated above the natural level of the surrounding parts, is called a tumor, so that these new formations would be ranked in the category of Tumors.

One of the chief qualities of any pathological formation resides in the character of the tissue of which it is composed. It may be formed from an excessive production of the normal tissues of the part, and thus not be in histological character in any way different from the textures surrounding it, and is only a pathological condition in respect to the amount and arrangement of the ordinary materials of which the region in which it is situated is com-

posed. Such a new formation is said to be a "homologous" growth, that is, a growth of character similar to that of the normal tissues. These growths form a large proportion of all the pathological formations of the body, and include in their number the great class of hypertrophies, the exostoses, most of the congenital tumors, and many growths of varying origin, such as the arthritic enlargements following a rheumatic attack, or the chronic enlargements which are produced by long-continued irritation of a part or organ.

The other division of new formations is called the heterologous class, in which the character of the growth is histologically different from that of the tissues surrounding it; in which it is situated; or with which it is in contiguity or continuity.

The growths belonging to this class of formations may be produced by a variety of causes. Among these, the element of heredity occupies a large place, and to this element is due a great proportion of this variety of pathological formations. To these growths also belong another peculiar feature, which is of the greatest importance; that is, that they often contain within themselves the element of *malignancy*, by which is understood a tendency to operate by their continued existence, in such a way as to cause the destruction of the parts or organs in which, or near which they are situated, either by invading their substance and thus displacing them, causing their atrophy or their absorption; or by the occurrence of new formations of the diseased pathological growth in the vicinity of the first formation, either by direct

transplantation, owing to the continued growth of the first centre of disease; or from the transference of the material of which the new growth is formed, by means of the blood or other channels, to new and sometimes distant locations. The same process is here carried out, as in the original location of the first spot in which the disease manifested itself. This process is called "metastasis," and these secondary productions are called metastatic growths. They may occur in near proximity to the first growth, or they may arise at a distance from the seat of first invasion, according to the conditions under which the metastasis has occurred.

To this latter class of pathological formations belong the various growths which have been classified as "cancerous." This appellation is not a fortunate one on many accounts, but it is mentioned because it has become fixed in the literature, and is understood to embrace those pathological formations which have a tendency to increase in size, to invade the domain of other organs, and to occupy their place; and, most of all, these growths have the habit of breaking down into some lower form of growth, or of undergoing processes of sloughing or other forms of necrosis, so that there is sooner or later a process of ulceration or gangrene in the substance of the pathological growth, with which is always associated a greatly increased amount of danger to the life of the patient.

The true distinction which should be made in relation to all pathological growths is one depending upon the tissues of which they are composed, a dis-

tinction resting on histological formation rather than upon gross external appearances or upon clinical peculiarities. The element of malignancy is dependent upon several distinct pathological conditions, which have their rise in the circumstances of location, histological structure and accidental accessory conditions surrounding the pathological formation. These latter may consist in the degree of vascularity of the part, in the density of the tissues, whether they be of soft or firm consistency, in the degree of exposure to injury, or to heat and cold to which the part is subject, or to other and variable conditions.

The great and only true distinction in pathological growths, however, consists in the character of the tissue-elements of which the growth itself is composed. This is ascertained by means of the microscope, and upon this depends to a very great extent the correct estimation of the nature and tendency of any pathological formation in the human body, both in relation to its effect upon the tissues with which it lies in direct contact, as well as its influence upon the well-being of the individual.

Generally speaking, those growths which consist under the microscope of a superabundant development of the normal tissues of the part, an overgrowth, or an unusual enlargement of the amount of some particular element, are of harmless character, and only produce signs of trouble from the increase in the size of the part, from weight, from pressure, or from the distorted appearance of the portion of the body which is the seat of the pathological growth. To this category belong the various congenital

tumors, by which is meant those which are born with the patient, increase in size in a ratio corresponding with the growth of the patient, and are not the cause of apprehension from any tendency to change into any other form of growth, or from any danger to the life of the individual, on account of malignancy. To such pathological growths are reckoned the fatty tumors (lipoma) which are so often observed upon various parts of the body, and which rarely exhibit any tendency to undergo changes to other forms of tissue, or to in any way vary from the original character of the growth. Sometimes these tumors reach an enormous size, and from their weight become an insupportable burden, and for this reason they are often removed by surgical operation. At times the fatty growth interferes with the movements of the limbs, preventing the patient from sitting in a chair when the tumor is situated upon the hip, or producing an unsightly deformity when located upon the neck, face or head, and then it is frequently removed for convenience or for purely cosmetic reasons. The growth itself, however, is usually quite free from any malignant tendency, is homologous in structure, and benign in character. Fatty tumors do not tend to invade other surrounding structures or tissues, nor are they liable to form new tumors in other parts of the body, such as some of the more dangerous growths are observed to do. In the fatty tumor we have an example of a simple, non-malignant growth, which may last indefinitely without danger to the patient from any change in the character of the growth,

and which is attended only with the inconveniences associated with its size, its weight and its effect upon the convenience and appearance of the patient.

Other examples of simple and harmless growths are seen in the common wart, which is so frequently observed upon the hands of many persons, and which has the added peculiarity of disappearing at times, and recurring after an interval either upon the same spot or in the near vicinity. The ordinary mole, or "mother's mark," is another variety of congenital growth, of pathological character, which is usually of innocent nature, although in some instances there is seen a tendency in these growths to change to some other form of tissue, and with this change is associated an increased tendency to malignancy. The rheumatic enlargements which are observed about the joints, or in other situations in persons who have long been subject to this disease, are the result either of the continued inflammation of the joints affected, which have become thickened in consequence, or they are due to the deposition in or about the joints of a mass of chalk-like material, composed in part of some of the elements which should have been removed from the body by the kidneys, and which form concretions in the cavity of the joints, thus causing a deformity of the parts, and often affecting the motion or at least the freedom of action of the articulation.

At times the hard tissues are the seat of enlargements upon their exterior or within their interior, in which their form may undergo material change and their function may become perverted. Thus we

sometimes observe exostoses upon the upper or lower jaw, or find that bony growth has encroached largely upon the cavity of the mouth from its pathological development into the buccal space; or it may produce other not less marked variations from the normal condition.

Some of the tumors associated with the hard tissues are of parasitic origin, and are of contagious or infectious character. Thus, there is a disease called Actinomycosis, which was first observed, and studied, upon the lower animals, especially upon cattle; which has, as one of its characteristic appearances, the enormous enlargement of the lower jaw, with the subsequent occurrence of ulceration, and the loss of the teeth and the destruction of the tissues in the region of the pathological growth. This disease has been observed in the human subject by Prof. Ponfick, of Rostock, and is thought to have been transmitted to man from the lower animals.

Certain classes of new growths possess a peculiar property of invading the parts in proximity to their seat, and thus extending into the surrounding tissues, which are displaced by the advance of the pathological growth, are absorbed, from its pressure, and are replaced by the new formation. These tumors are destructive to the organs in their vicinity, and they increase by occupying the space belonging to other structures which have been destroyed by the growth of the tumor. These tumors are dangerous to the structures in their neighborhood, but do not tend to form new deposits of the diseased growth in other parts of the body. Such growths are said to be

locally malignant, but *generally* benign, that is, they destroy the tissues in their vicinity, but they do not tend to produce new colonies of the disease in other and remote situations of the body. In distinction to this, is that great class of pathological growths which, at the same time in which they are increasing in size in the situation in which they were originally developed, also form new plantations of the same disease in other and remote parts of the body, so that after a time there is not only the original disease at the place where it was first noticed, but there is also a number of new and separate points in the body in which the same disease is to be found, and in which it is running its course in the same way as in the seat of first development. These growths are called malignant, in the broadest and most general sense of the term, and belong to the most dangerous group of pathological formations. The new colonies are produced by the transportation of certain elements of the disease, by means of the current of the blood or by other channels, to distant parts of the body, where they become seated, and begin to grow, and reproduce the original disease in the new location. This process of new production is called "metastasis," and these new centres of disease are called "metastatic growths." Such pathological growths are always of an extreme degree of malignancy, and are the most frequently fatal of all the new formations which are observed in the human body. These growths are, by many able men, grouped into one general category, in accordance with their clinical characteristics, as belonging to the group of

Cancer; but this name is not a desirable appellation for any class of new formations, from the fact that the tumors may be of different histological character and of different physical properties, and yet be malignant. It is desirable in the nomenclature of pathological growths to call them by a name which shall convey an idea of the histological composition of the growth; rather than by a name which is common to many varieties of pathological formation, and, therefore, cannot convey any definite idea of the structure of a tumor in any given case.

CHAPTER XXVIII.

CLASSIFICATION OF PATHOLOGICAL GROWTHS.

The first and most important step in the investigation of a pathological growth is to determine the tissue of which it is composed, that is, to decide whether it arises from the normal tissues of the part, and is only an inordinate development of the normal structures to be found in that region; or if it is composed of some new and unexpected structure, not belonging to that part, or, indeed, often not belonging to any part of the body. The next point is to establish what the structure of the growth really is. To investigate how it is formed, if it is vascular, if it is composed of connective tissue or of epithelium, of cartilage, of bone, or of some other tissue. Any or all of these histological elements may exist as a pathological production, when developed in unusual places or in unusual amount, and thus from being a useful part of the body they may become the cause of disease, or of greater or less disturbance.

Certain pathological growths are found to consist of a tissue different from any found in the adult body, and, therefore, unlike any of the tissues of the part in which the growth is seated. These new formations may be very confusing, but they will generally be found to correspond to some of the immature forms of the human tissues, or to their derivatives, and thus will be ranked with the class of growths to which

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they belong. It is well known that the tissues of the adult human body are developed from a substance vastly different, which in the early days of intra-uterine or embryonic life constitutes the whole of the body of the embryo. These primary structures are replaced by the organs and tissues of a later period, and at birth or soon after, there is none of the embryonic tissue to be found in the body, or only limited and detached portions in the interior of the long bones, or in a few other similar situations. The transitory embryonic material, called embryonic connective tissue, is almost, if not wholly, absent from the body of the infant at birth. It has nothing to do with the finished structures of the body, but seems like a formative material of plastic nature, out of which the future organs and tissues of the body are developed; and when this is completed the embryonic tissue disappears, and is nowhere to be found.

In certain pathological growths, however, there is a reappearance of this material, the body of the tumor being found to consist of connective tissue similar to that observed during intra-uterine life, but now appearing as a heterologous product during adult life in the shape of a tumor. This tumor may not be of malignant character even if it is composed of elements not found in the human body in a state of health, but it may be developed as a transitory tissue, for the second time, and may again serve as the material out of which other tissues are to be developed, as is seen in the process of granulation, in which a wound or injury is the seat of development of a round-celled tissue, such as is not found any-

where in the healthy adult body. This now only furnishes the means of filling up any loss of tissue, for the time being, out of which the various injured parts or tissues are repaired or again developed, much as the organs and tissues were originally developed out of the embryonic connective tissue in the period of intra-uterine life. Thus we see the curious phenomenon, that a tissue exists in the earliest formation of the body of the embryo, from which the structures of the new beings are constructed; and that in cases of injury to the body in after-life, there is a reappearance of this formative or embryonic material, by the help of which the repairs are carried on until the healing of the injury is completed, when the granulation, or embryonic tissue again disappears and is nowhere to be found in the body.

The important and particular point in relation to embryonic tissue is this: Granulation tissue, or embryonic connective tissue, *is not a permanent tissue.* It only exists in the body of the embryo as a transitory material, from the conversion of which another and entirely different material is to be produced. If, now, embryonic tissue reappears in the adult body, at a time when there is no process of repair going on, and if it accumulates in any considerable amount, it is easily conceivable that it may undergo similar changes to those belonging to it in its usual and normal conditions. As it is never a permanent tissue, but is always changing to other and different forms of tissue, so when it appears in the form of a pathological growth, it exhibits a ten-

dency to undergo further changes, either in the way of extension of the disease, or more frequently, in the rapid decadence of the tissue already formed.

Thus it is seen that the pathological growths in the body may be of various character, and that the nature of these growths and their influence upon the body at large is due to the circumstances of their structure, their location, and, to some extent, depends upon the nature of the different textures entering into their composition. Their study is to be pursued in relation, also, to their clinical behavior; as the surroundings of a growth make a vast difference in its course, and are often the means of determining its effect upon the system of the bearer. Prof. Virchow, than whom no greater authority in pathology exists at the present day, makes the statement that in all cases of histological examination of morbid growths, the most careful study of the clinical symptoms attending the development and growth of the tumor should be made, as the microscopic examination alone is not sufficient in most cases to warrant a positive opinion.

In addition to the general varieties of tumors enumerated above, there are the numerous forms of swelling caused by the retention of some fluid within its gland, or the accumulation of some liquid in a cavity which should not exist in the healthy body, and which thus causes a tumor or swelling in the part affected. These tumors are called "cysts," and are observed oftener than in any other manner, in the case of obstruction of the duct or orifice leading

from a gland, the occlusion of which causes the accumulation of the secretion within its gland or the duct, which then becomes enlarged, and is often so enormously dilated as to present only a thin wall containing the fluid. The liquid often accumulates to a great amount, so that a large swelling occupies the site of a small gland. These cystic collections present a peculiar phenomenon upon being lightly tapped with the finger. They give the sensation of *fluctuation*, which is a peculiar wave-like motion beneath the finger, and which belongs only to tumors with a fluid content. We may, therefore, by this sign determine if the swelling be caused by the growth of a solid tumor, or if it be due to a collection of fluid in some cavity in the part. These cysts are not rare in the mouth, where there are several large glandular structures, the secretion from which is often obstructed in its escape, thus causing the accumulation of a considerable amount of fluid in the glands or in their ducts, and producing a corresponding swelling in the part of the mouth in which the gland itself is located, and which intrudes to a greater or less degree into the cavity of the mouth.

Prof. Virchow calls this class of tumors "retention-cysts," because they originate from the retention of the secretion of the glandular bodies contained in the part. The obstruction of the duct causes the swelling.

Such tumors are not uncommon in the parotid region, from obstruction to the flow of the secretion

of this gland, and the swelling is situated in the region of the gland, just in front of the ear. One of the symptoms which may occur in any affection of this gland is paralysis of the muscles of the same side of the face, due to the pressure of the swelling upon the trunk of the facial nerve, which passes through the gland on its way to the muscles of the face. The presence of paralysis of those muscles of the face which are supplied by the facial nerve, should at once direct attention to the parotid gland as a possible seat for the disturbance of function in the nerve, caused by pressure in its passage through the gland.

It will therefore be seen that the various forms of pathological growth can only be differentiated one from another by attention to a system of investigation which shall determine the points of difference between the several varieties. Their study, however, in regard to their character must be based upon observation of their derivation and structure. We are thus obliged to look to anatomy, both macroscopic and microscopic for the solution of the question as to the origin and the formation of these growths, and from these results we may draw certain conclusions as to the character, dangerous or otherwise, of the particular growth under consideration.

The importance of a competent knowledge of the histological structures of the tissues of the body at once becomes apparent. Inasmuch as the greater part of all the pathological formations of the body consist only of derangements of the normal struc-

tures, it is imperative that the observer should know the relations and the general characteristics of the normal tissues of the body before a correct opinion of the pathological deviations of the tissues can be rationally formed. Upon this conception the description of the pathological growths observed within the domains of dental surgery will be conducted.

CHAPTER XXIX.

HYPERTROPHY.

Prof. Austin Flint has described hypertrophy thus: "The term Hypertrophy is applied to enlargement of a part from an increase of its normal constituents, the structure and arrangement remaining essentially the same. In simple hypertrophy there is an increase in the size of the anatomical elements, but not in their numbers. In hyperplasia the number of these elements is augmented."

The hypertrophies of the mouth and teeth may affect any or all of the tissues therein contained, and may be of so slight a character as hardly to attract the notice of the patient; or they may reach so extensive a development as to seriously impair the comfort or even to endanger the life of the patient, from interference with the processes of mastication and nutrition. The hard tissues of the roof of the mouth are the seat of frequent hypertrophic changes, which may be confined to a small area, or may extend over the entire vault of the oral cavity.

In cases of simple uncomplicated hypertrophy there is usually no indication of disease of the tissues. There is no ulceration of the mucous membrane, nor is the patient a sufferer from pain or distress of any kind. There is simply an inordinate increase in the bulk of the normal tissues of the part, with the encroachment and disturbance of other structures

which such an enlargement of the tissues would of necessity cause in a contracted space as is that of the mouth. The hypertrophied tissues are supplied with blood vessels and nerves, the same as are the normal parts about, and the histological elements are all of healthy character.

In the hypertrophy of the teeth there is often a greater deviation from the normal characters of these organs than in the hypertrophy of other parts or organs. This is due to the fact that the teeth are so situated that any disturbance in their original development, or any disarrangement in their growth, is the cause of wider divergence in the form and relations of the tooth, than is the case in such changes in most of the other tissues of the body. The hypertrophies of the teeth are of two general kinds. First, that due to the congenital variation of the form of the tooth, and which is born with the individual, and is at no time the subject of disease or the occasion of any inconvenience to the individual. This form of hypertrophy is like the deformities occasionally seen in otherwise healthy individuals in whom there is an excessive production of tissues or of entire parts.* Those patients sometimes are born with an

* "HEREDITARY POLYDACTYLY AND ANOMALY OF DENTITION." *British Medical Journal*, April 14th, 1888.—In the Naturforscherversammlung, recently held in Wiesbaden, Herr Thomas, of Freiburg, brought forward a case of the above-named anomaly, which derived special interest from the fact that there was also hereditary malformation of the teeth. Polydactyly had existed for several generations in the father's family, and similarly dentitional anomalies affected the mother's side. Some of the teeth were always wanting, and the primary dentition in many cases persisted for a

increased number of fingers or of toes, or they may have an abnormal development of some part of the anatomy of certain organs, in which there is, however, no indication of organic disease. Thus, in one of the metropolitan hospitals, a patient was received for surgical treatment, who presented the curious phenomenon of six fingers on each hand and six toes on each foot. The person was entirely well; there was no sign of any disease in any part of the system; there was only the abnormal increase of the number of perfect organs upon each extremity, which were removed by surgical means, and the person made a perfect recovery. In another patient known to the writer, there is on one hand the formation of a perfect thumb in addition to the thumb naturally belonging to the hand, so that the patient never could wear a glove upon that hand. The patient is perfectly well and strong, the distortion of the hand producing no effect upon the condition of the body. In the same manner there is occasionally seen in the mouth a variation in development from the usual forms, due to some cause of congenital character, and in no way affecting the health of the patient nor interfering with his nutrition. The affection may be confined to the roots of the teeth, or of certain of the

long time. The offspring combined both kinds of irregularity, for one child, aged eleven years, exhibited besides polydactyly, only two upper, and no lower incisors. Milk teeth were present and there was a corresponding defective development of the jaw. A brother had six fingers on one hand and seven on the other, also six toes on each foot; one pair of fingers had grown together; all the rest, together with the toes, were separate and well formed; the condition of the teeth in this case is not stated.

teeth, and is then the cause of changes in their proportions and outline; the part which protrudes from the jaw being more or less misshapen and often clubbed, and the root, which is the seat of the hypertrophic change, being frequently much enlarged, and sometimes transformed into a rounded and blunted extremity in which no similarity to the ordinary and natural tooth can be detected. In the most of these cases the deformity of the tooth is not discovered until the tooth is extracted, or until there exists some defect in its nutrition, or pressure is produced upon other and surrounding structures by which the patient is made to suffer acute pain. At times the excessive development of the root of the tooth causes a high degree of vascularity in the periosteum, and this in its turn occasions a sensitive condition in the nervous structures of the root of the tooth, which is the source of much suffering to the patient and brings him to the consulting room of the dentist. Even then there may be no indication other than that afforded by the study of the complexity of the symptoms to direct attention to hypertrophy of the root of the tooth as the cause of the trouble, and usually only on removing the tooth is the hypertrophy discovered. The extraction of hypertrophied teeth is often a matter of great difficulty, owing to the frequent enlargement of the root of the tooth to such an extent that the apex is much larger than the neck of the tooth, so that the root cannot pass through the orifice which incloses the neck and body of the organ. In such cases the alveolar process is not infrequently more or less injured, and sometimes extensively frac-

tured or comminuted. In many cases the body of the tooth is broken or crushed in the attempt to extract it, and the crown is separated from the remainder of the tooth, which is still inclosed in the tissues of the jaw.

The character of the growth which takes place in hypertrophy of the root of the tooth is generally a new formation of bone, and not the increase of the cementum of the root texture. The periosteum of the root of the tooth is also the periosteum or endosteum of the alveolar process, and is the lining of the cavity in the alveolar process, at the same time that it is the covering of the root of the tooth. It is a well-known fact that the chronic irritation, or a low form of inflammation of the periosteum will result in the production of a new growth of bone beneath or upon the membrane. Thus we see how it occurs that the enlargement at the apex, or upon the root of the tooth in a state of hypertrophy is composed of bone tissue, and not of the cementum of which the body of the root of the tooth is composed. The parts are not usually further diseased, and after extraction of the affected tooth the cavity closes quickly and kindly, and the patient is none the worse for the enlargement.

The mucous membrane of the alveolar process is sometimes the seat of an hypertrophic condition, due to a long-standing irritation of the part, from disease of the tooth socket, or the effect of accumulation of filth about the root of the tooth, or from other causes. In these cases the membrane is often found thickened, it is seen to be elevated, so as to

extend to a higher point upon the teeth than usual, and is brawny and elastic to the feeling. Occasionally the hypertrophy may be observed as a velvety elevation of the surface of the membrane, which at times rises up at the neck of the tooth so as to cover more or less of its body, from which it may be pressed back, and the tooth be seen inclosed in the mass of tissue about it.

At times the presence of some form of disease may occasion hypertrophy of the tissues in its vicinity. Thus in the case of cancer, we may see in the neighborhood of the cancerous disease, an increase in the amount of the normal tissues of the part, due to the irritation caused by the nearness of the disease. It is at times quite difficult to understand the relation which exists between the diseased tissues and the increased amount of the normal tissues in the immediate vicinity.

CHAPTER XXX.

CARCINOMA.

Among the forms of tumors which are termed "malignant," and which tend to destroy the part in which they are situated, and to threaten the entire organism, by destructive growth, or by new formations in the way of metastases, is one of great importance, which has received the name of "Carcinoma." This form of growth belongs to that class to which the name "cancer" has been applied; under which term is also comprehended a variety of other forms of pathological growth, the distinguishing characteristic of all of which is their malignancy, and their tendency to return after removal.

These growths are of varying origin, some of them being derived primarily and exclusively from the connective tissue, and consisting of this tissue alone, while other forms are derived from the epithelial covering of the body, or from some of the internal epithelial structures, such as the lining of the alimentary canal; or from some of the glandular structures of the interior of the body. These last-mentioned growths, the epithelial growths, are grouped under one general head, and belong to the class of the Carcinomas. In order to understand the origin and the construction of this class of tumors, it is necessary to call attention to the peculiarities associated with the development and increase of epithe-

lium, and then to trace the changes which occur in a pathological growth composed of this histological element.

If we turn to the structure of the skin, we find that the epithelial covering of the body is developed from a layer of the dermal textures called the *rete mucosum*, and that the deeper portion of the epithelium is composed of a single layer of cells of almost columnar shape, standing on end, upon the rete mucosum above mentioned. This arrangement is continued in all portions of the skin, so that the appearance of the skin from any part of the body is always the same. The lower layer of cells is gradually lifted from its seat by the development and growth of a new layer under them, so that what was at one time the lower layer of epithelial cells is afterward found to be removed toward the surface of the skin by the growth of new layers of the same tissue beneath them. In this way the cells which are formed at the deepest part of the epithelial layer are gradually raised toward the surface, until they at length form the cuticle, and are removed from the skin in washing, or by some other means, as dead and useless material. The lower row of epithelial cells is placed against the connective tissue, for the rete mucosum is composed of connective tissue elements, and is supplied with arteries, veins and nerves, which the epithelium never has. From this source the youngest epithelial cells obtain abundant nourishment, by absorbing the nutritious material in the form of serum and albumen which abounds in the connective tissue, and which is capable of support-

ing the vitality of many animal tissues. It is not necessary that blood should everywhere circulate for the nutrition of the textures of the body. The cornea, which forms the transparent membrane covering the front of the eye, through which we see, is composed of elements which depend for their nutrition upon the absorption of material from the surrounding connective tissues, as no blood vessels naturally exist in the domain of the cornea. In like manner the epithelial covering of the skin is supported by absorption of nutrient material in the shape of fluids from the connective tissue immediately below the level of the epithelial border, and the epithelium then proliferates from this point upward toward the surface of the skin. The amount of material which is at hand for the support of the epithelium is quite largely in excess of the requirements of the lowest layer, and is absorbed through the first few layers to minister to the support of the cells which have been removed from their original seat by the proliferation of the new cells at the margin of the rete mucosum.

For a time, then, the epithelium is still a vitalized and living tissue after it has been removed by underlying cells from the place of its first formation; and it is still composed of large cells with distinct nuclei, and with frequently a toothed margin whereby it is united to its companion-cells in forming a protective covering to the surface of the body. After being raised to a certain extent, however, from its original location upon the rete mucosum, the epithelium cells lie at such a distance from their source of supply that the amount of nutritive material is not

sufficient to extend through the intervening mass of new-formed epithelium, and to maintain the vitality of these older cells; and these cells then begin to suffer decay, and after a little more elevation toward the surface of the skin, they are seen to be smaller than before, and to take on a shriveled appearance, and to lose their nuclei, which until this point was reached, were distinctly visible. From this time the epithelium composing the protecting covering of the body is comprised of a mass of dead and dried cells of epidermis, which become more and more desiccated as they approach the surface of the skin, until they are cast off as mere dried particles of cuticle such as are combed from the hair or can be scraped from the skin of the arm with the flat edge of a knife, without injuring the tissues or causing pain.

It will be perceived that the cells of epidermis, in their growth from the lower layer of their development toward the surface of the skin, retain their vitality for a certain length of time after they have left the boundary of the connective tissue and have started on their way to the surface. For a certain distance from the level of the connective tissue they can still absorb nutriment through the cells which have developed below them, are younger than they, and have lifted these earlier cells away from the connective tissue where they were formed, and for a certain time lay in contact with the connective tissue. At a certain distance, however, from the border of the connective tissue the cells of the epithelial layer cease to receive sufficient nutritive material to support their vitality. The entire supply is used up by the cells

lying nearer the connective tissue; and these cells, which are daily becoming further and further removed from the point of their origin, the rete mucosum, or the connective tissue, at length die, from lack of sustenance, and begin to undergo the changes due to their necrosis, to become dried and flattened, to lose the nucleus which has before this time characterized them, and to form the outer horny or insensitive layer of the epidermis, the cuticle. Thus, it will be seen that the epithelial cells of the body are dependent on other tissues of the body for their nutritive supply, and that when they are removed to any great distance from their source of nutritive supply by the development of new layers of epithelium beneath them, they lose their vitality, and begin to undergo a retrogressive change in the direction of desiccation, and are at last cast off from the surface of the skin as a part of the worn-out cuticle. For a certain distance, epithelium is a *living, vitalized* tissue; beyond this limit it is a dead and useless mass of débris, which is finally cast off from the body.

Now, we have observed that the epithelial tissues are, without exception, situated upon the external surfaces of the body; that they are not contained within the serous or other closed cavities of the organism, but without exception are so situated that they communicate with the outside of the body, and with the air. When they are cast off, they are always thrown off upon the surface of the body or into passages or channels which communicate with the outside of the body. They are never retained within the cavities of the body or limbs, or in any other

locations, under any normal or usual conditions. If this should occur, we should have an accumulation of cast-off epithelium contained in some portion of the body where it could only act as a useless and disordered incumbrance to the organism. This really takes place in the formation of one of the retention tumors, called Atheroma, or Wen, in which the epithelial formations of certain glandular structures are retained in the cavity of the gland, from the occlusion of its orifice; and there is at length formed a mass of greater or smaller size, composed entirely of the accumulated epithelium so retained, or of the substances produced by its decomposition, with occasional additions of hair, or other epidermoidal structures. It is as if a portion of the skin were turned into the flesh, and were closed in on all sides, so that it formed a hollow ball, and when the epidermis is cast off in such a case, it is simply cast into the middle of the ball, and is there retained, because no orifice to the surface of the skin exists by which it may reach the surface. The entire contents of the tumor is dead epithelium or its decomposed remains.

If, now, we suppose that a portion of the epithelium of the surface of the body should, for some unknown reason, start to develop downward into the connective tissue, instead of upward toward the surface of the body, we should have essentially the same result which we have described in respect to the wen. We should find a mass of epithelial development where no epithelium should normally exist. Connective tissue and epithelium do not mix. Where connective

tissue exists, epithelium is not found, unless it simply comes up to the connective tissue, and is attached to it as a boundary, but it does not enter into the composition of the connective tissue. The downward development of epithelium, therefore, must cause the displacement of a certain amount of the connective tissue, to allow space for its advancement. The epithelial prolongation, therefore, resembles a finger introduced into a mass of dough; and has almost the same effect as would a foreign body introduced into the subcutaneous tissues of the part. There is a certain amount of inflammatory reaction at the seat of the epithelial invasion, but the growth goes on; and larger and larger masses of epithelium are formed in the connective tissue;—in a location, therefore, in which epithelium does not belong, and where it is never found in a state of health. It is the invasion of the connective tissue by the unnatural prolongation of epithelial processes into it, which constitutes the histological element of one of the largest classes of that variety of disease called Cancer; and it is the sole anatomical cause for all the phenomena connected with the growth of Carcinoma in any of its forms. If we examine any form of carcinoma, located in any part of the body, at an early stage of its development and under favorable conditions, we shall find that it takes its origin at the point of its first appearance, from the development and growth of epithelial tissues in a place and under conditions under which epithelium is not normally developed or found. The intrusion of epithelium into the

domain of the connective tissue is the histological cause of carcinoma; and the origin of this variety of cancerous disease is to be found in a disordered growth, and a wrong direction of the epithelial formations of the body.

There are several different varieties of epithelium, and there are correspondingly varying forms of carcinoma, but the disease is the same in all essential characters, and the progress and result are the same, except in so far as these may be influenced by the accidental circumstances attending the development of the disease in certain regions of the body, or the variations in blood supply, or other subordinate circumstances.

It is not easy to obtain the typical picture of developing carcinoma, for the reason that at this time the disease is so slight in character, and so small in extent, that the patient is unable to think that it is the beginning of a serious and probably a fatal malady; and, also, for the reason that the early development of the disease is often hidden in cavities, or so situated that it escapes the attention of the patient until the pain or other symptoms attending its further development are sufficient to call the disease to the patient's notice. Thus, in a case recently seen by the writer, which ended fatally in a short time, the carcinomatous disease commenced in the deepest part of the navel, and the patient, a lady, did not seek medical advice until the pain and weakness caused by the disease had so reduced the strength that all hope of any alleviation of the disease was at once abandoned.

Wherever the carcinomatous disease is located, and under all the conditions which are observed in its course, the main element is the encroachment of the epithelial tissue into territories in which, normally, no epithelium is developed, and where it does not belong. The manner of growth is by prolongation of masses of the epithelium in the shape of finger-like processes into the surrounding structures, which it displaces, and which are so crowded by it that they are removed by absorption, or are destroyed by the unaccustomed pressure of the new growth. In this way the connective tissue is removed, the muscles are caused to disappear, the fat is absorbed, and in the place of all these structures is seen the development of masses of epithelium, of the kind natural to the part in which the carcinomatous disease was first developed. After a time, the blood vessels of the part may become involved in the diseased tissue, as the new growth increases around them, until it quite envelops them in its own tissue. It is then possible that certain of the vessels, both of arterial and of venous character, may be penetrated by the cancerous growth, and that hemorrhage may ensue, or that particles of the disease may enter the current of the blood, and may be carried to other and distant parts of the body, where, then, they may form the starting-point of a new deposit of the original disease. Here, again, the epithelial cells are of the same kind as those observed in the original seat of the disease, and they increase in the new location, forming masses of disease similar in all respects to those noticed at the point of origin of the

carcinoma, when it first appeared in the patient. The deposit thus formed is called a metastasis, and is a secondary formation, of the same character in all essential respects as the original disease. Other metastases usually occur if the patient survives long enough after the disease has become thoroughly developed.

CHAPTER XXXI.

ULCERATION IN CARCINOMA.

The destruction of the tissues which follows the invasion of carcinoma is due, as has been shown, to the enormous development of epithelium in locations in which this tissue does not naturally belong, and under circumstances in which no epithelial tissue is naturally produced. The next stage, that of ulceration of the carcinomatous mass, is produced, however, by conditions affecting the epithelium alone. It is well known that all cancerous affections are characterized by a tendency to ulcerate, and thus add the dangers of an open suppurating wound to those attending the formation of a malignant tumor. It has been shown on a previous page that the epithelial cells which are produced upon the rete mucosum undergo a process of gradual starvation from lack of nutritive material as they are pushed further and further away from the surface upon which they were developed, until they at length are cast off from the cuticle as dead and withered particles of the desiccated epidermis.

For a certain distance the epithelium is a vitalized and living tissue; after this, the epithelial cells are simply so much dead material, which nature gradually forces to the surface, until they are thrown off with other débris of the system. Thus we see that the line of the advancement of the epithelial growth

is followed at a regular distance behind it, by a line of necrosis, represented by the death of the epithelial cells which have been formed; and that this necrosis of the cells must follow every advance of the epithelium into new domains, and thus carry the *ulcerative* process into every part into which the *cancerous* process has entered. If the cancerous disease has attacked the lip or face, it gradually spreads, until the entire face is affected, and the necrosis of the cancerous growth causes great loss of substance, until the entire skeleton of the face may be exposed, the tongue may be destroyed, the nose may be lost, and the patient may at length suffer a tedious and agonizing death from gradual starvation; due to inability to take food, owing to the destruction of the organs of mastication and deglutition.

If the carcinomatous mass is allowed to go on undisturbed, it is sure to communicate with the lymphatic channels which are everywhere distributed through the tissues, and the result of this is seen in the swelling and hardness of the glands located upon these lymphatic vessels which are nearest to the seat of the original disease. These glands are at first only indurated or swollen from the irritation of the cancerous mass which is situated in their vicinity; but soon they are found to contain the real elements of the carcinomatous disease in the shape of deposits, or new depots of epithelium in organs in which normally no epithelium is found, and into which it has been transported by means of the lymphatic vessels, thus forming a metastasis of the disease from its

original seat to the nearest lymphatic glands. After a time the disease breaks through these glands, which act like a temporary barrier to stop the advance of the pathological process. The cancerous disease then passes into the larger lymphatic channels of the body; or it enters the veins or arteries, and is then transported by the current of the blood into any part of the body where it may chance to be carried, and there produces new colonies of the same disease, called secondary metastases. The disease has now arrived at such a degree of dissemination that the chance of the patient surviving its ravages or of receiving any benefit from treatment are extremely small, because in all the locations in which it has appeared, the same process of exaggerated epithelial development is carried on, and the same consequence of subsequent necrosis of the epithelial new formations takes place at a point just behind the line of advance of the disease. It frequently happens that the internal organs of the body are the seat of the secondary metastases of cancer, and of these the liver is most often affected.

When the disease has reached this degree of development, and has thus appeared in the internal portions of the body, and has invaded the visceral organs, there is generally observed a new train of symptoms, due to the poisoning of the system of the patient by the cancerous infection, or virus; or due to the presence of so many centres of malignant disease in the important organs of the patient's body. The color of the skin becomes yellow, the skin is dried

and shriveled, there is loss of strength, and extreme emaciation, with increasing weakness, and the digestion as well as other functions of the body become enfeebled and unable to fulfill their office in the nourishment of the patient. This condition is called "marasmus," and is one of the final results of the general invasion of the body by any specific form of grave disease, and is threatening, more from the fact that it is an indication of profound exhaustion of the powers of the body, than from the effects of any one of the symptoms which go to make up its presence.

The life of the patient is now usually of short duration, and death most frequently occurs from sheer exhaustion, or from starvation, or from the failure of the system to assimilate the food taken, which is only another form of starvation.

There may be hemorrhage from some blood vessel which has been opened, and this may quickly terminate the life of the patient by sudden collapse. Occasionally the disease is observed to make a metastasis to the brain, and the later period of the patient's life may then be obscured by the signs of a grave disturbance of the cerebral functions, or by entire unconsciousness.

We see, therefore, that the histological character of carcinoma, one of the most uniformly malignant and universally fatal diseases we know, is comprised in one of the most abundant and well-known tissues of the body; and that this tissue is only the cause of the disease when it is found growing under unusual and abnormal conditions. The clinical symptoms

attending this form of cancer are due to the presence of epithelium in locations where it does not belong, and also to the fact that the epithelial tissue can only retain its vitality for a certain distance from the basis of connective tissue where it is formed; and that the necrosis of the epithelium when it can no longer obtain sufficient nourishment, is the cause of the ulceration and the frightful loss of tissue which accompanies the ravages of this dreaded disease.

From this it will be seen that a pathological growth, even of malignant character, may not differ in any way from the ordinary constituents of the human body, the simple variation of location and arrangements of the cellular elements, or their relations with the surrounding tissues being often quite sufficient to induce the features of malignancy into the formation of an otherwise ordinary tumor. Not all epithelium will form a malignant growth when it is placed in relation with the connective tissues, and it is impossible to originate the disease in animals; though cancer is often known to follow certain forms of prolonged irritation of the part affected, in the human subject. There seems to be a hereditary or an acquired tendency to the disease; a congenital predisposition to cancer, such as affected the members of the family of Napoleon I, which leads to the formation of cancer in their descendants. In a case known to the writer and reported by him in Graefe's *Archiv*, carcinoma was developed in the conjunctiva of a clergyman seventy-two years old, whose mother had died of cancer located in another part of the

body many years before. The reason why, or the manner in which, the tendency to certain diseases is thus transmitted from one generation to another is not known; nor is the specific quality of the infective material, which can retain its fatal power through so many years and then develop its malignant character, at all understood.

CHAPTER XXXII.

MALIGNANT GROWTHS, CONTINUED. SARCOMA.

The other great class of malignant growths which is included under the general name of Cancer, is produced in another manner from that just described and is developed from a different tissue. These growths are developed from the *connective* tissue, and consist of normal or degenerated connective tissue. They are located in any part of the body, are not necessarily in any constant relation to any special organ or structure, such as we have seen that carcinoma always exhibits. Unlike the carcinoma, the connective tissue growths do not necessarily undergo degenerative or retrogressive changes. This branch of the malignant growths of the body is called "Sarcoma," from its resemblance in gross features to the flesh of an animal when recently cut. They are sometimes called "flesh tumors" on this account, by the older writers upon morbid growths.

Being produced from the connective tissue, the tumors belonging to the sarcomatous group are developed *beneath* the skin, and not upon it or in its texture. The pathological growth may be observed only as an increase in the connective tissues of the region, without definite boundaries or sharp outline, and may not differ in any gross characters from the tissues about the spot where it is located. The increase in the size of the tumor, the fact that it dis-

places the normal tissues and organs by the infiltration of their textures with the elements of its own histological structure, and thereby causes the disappearance of important parts or organs, from the encroachments of the morbid growth, gives to this class of tumors a degree of importance which they would not otherwise possess. The loss of substance from these tumors is due in part to the fact that the large increase in the element of connective tissue, not infrequently is followed by the softening of the textures of the new tissue. This is thus rendered more easily liable to injury or disease, and therefore much more likely to take on the appearance of degenerative disease of the textures of the tumor than is observed in cases of pure hypertrophy of any of the subcutaneous tissues. Simple hypertrophy, even when the increase in the size of the part is so great as to cause distortion and inconvenience to the patient, is not often followed by the degeneration of the tissues thus formed. In the sarcomatous growths there is, however, a tendency to change in the histological elements of the growth, and the diseased tissue also possesses the additional peculiarity of easily being transported to other parts of the body, where it forms the nidus for the development of the malignant disease at this new location.

The chief difference in the location of the Sarcomata in distinction from the Carcinomata is found in the character of the tissues from which each of these two varieties of morbid growth is formed. The carcinomata, arising in all cases from epithelium, is first developed upon some surface or in some struc-

ture in which epithelial tissue is present, either as a normal constituent of the part or as an accidental condition. As has been shown, epithelium is the constituting element, the invading factor, the essential substance of the carcinomatous disease. In all its advances, epithelium is the one indispensable element. In the sarcomata, on the contrary, the disease arises from the connective tissue, and can take its origin in any part of the body in which this tissue is found. When we realize that connective tissue is the one *universal* tissue, that in any and all parts of the body it is the supporting and connecting substance between other and various organs and tissues, and is associated with every structure of the entire anatomy, we can at once perceive that the growths arising from this tissue may be found in all portions of the body, and in relations with all the textures which are located beneath the skin and mucous membranes. Such a growth arising from the fibrous textures of an aponeurosis would be called a fibro-sarcoma; when arising from the structure of a lymphatic gland, it might be called an adeno-sarcoma; when originating from the tissues of bone (from the connective tissue contained in the canaliculi or other textures of bone), it would be designated an osteo-sarcoma; and when it arises from the delicate reticulated connective tissue found in the internal structures of the nervous system, it receives the title of glio-sarcoma. Thus it will be seen that the connective tissue growths, though arising from the same substance as a basis, are variable, according to the form which the basis takes in the different parts of

the body. Not all the varieties of sarcoma are malignant, in fact, some of them are distinctly non-malignant, but the origin of the growth is at all times the same; the only exception in character being found in the *kind* of connective tissue which affords origin to the growth. The degree of malignancy is found to be associated chiefly with the size of the cellular elements of which the growth is composed, and the finer the elements, and particularly if there is a tendency to present a variety of cellular forms in the same growth, the greater is the degree of malignancy of the tumor. The change in histological structure is always in the direction of less stable and more feeble forms of tissue, and these present a greater liability to break down and to undergo gangrene, or in other ways to become necrosed; and thus to inaugurate the destruction of the tissue, and to produce an open ulceration at the seat of the tumor. When the loss of substance has thus once occurred in a sarcomatous growth, there is little probability of spontaneous healing of the tissue taking place, but the course is usually in the direction of a progressive increase of the ulceration, a greater loss of tissue, and the rapid exhaustion of the strength of the patient from the loss of fluids, and the extension of an acute gangrenous process in the vicinity of the growth.

One of the forms of Sarcoma is not infrequently met with in the structures of the jaw. It most commonly takes its rise to one or the other side of the symphysis, and usually in the region of the canine or bicuspid teeth. The form in which it is often

observed is that of an oblong, more or less raised swelling and thickening of the alveolar process of the lower maxilla, with a softening of the bony structure and a loosening of the contained teeth, which are often found out of their normal relations with the rest of the denture and frequently placed at an angle with their proper direction. Not infrequently one or more of the teeth have become loosened to such an extent, by the softening of the alveolar process, that they have been extruded from the jaw, or have become so troublesome that they have been extracted by the dentist for the convenience of the patient. If a jaw thus affected be made the subject of examination, it will be found that an instrument applied to the alveolar process encounters much less resistance than is natural in the part, and by moderate pressure may sometimes be driven into the interior of the maxillary bone. The outline of the jaw is usually much distorted, and the line of the denture is generally destroyed. There is more or less invasion of the floor or roof of the mouth, and the tongue is crowded to the back of the oral cavity, or to the side of the mouth opposite to that upon which the pathological growth is situated. The mucous membrane may be intact over the entire surface of the growth, and there may be no appearance of disease in the relations or secretions of the salivary glands. If the growth be carefully observed, it will be noticed that it rapidly increases in size, and that the consistence of the growth itself, and that of the surrounding parts, is changed, so that an increased softening of the tissues in and about the tumor is observable.

With the loss or extraction of the teeth included in the area occupied by the tumor is often associated the first appearance of the destructive or malignant character of the pathological growth. The cavity occupied by the tooth or teeth is often the seat of the first appearance of the ulceration or necrosis of the new growth, and exhibits the first positive indications of its dangerous character. If the disease be removed by section of the maxillary bone on each side of the area occupied by the disease, it will be found that the whole interior of the bony tissue has been invaded by the sarcomatous development, and that the substance of the bone has been in great part destroyed, and replaced by the tissue of the tumor. The periosteum is sometimes apparently intact upon the outside of the bone, and frequently there is seen a formation of new bone as the result of the irritation of the periosteum from the proximity of the diseased process, so that oftentimes strange and fantastic pictures of bony development are thus produced. If sarcoma in most of its forms is allowed to advance upon its course without the employment of preventive or restrictive treatment, we observe a metastasis of its elements similar to that noticed in speaking of the Carcinomata. After a time, which is variable in different cases, we observe in the regions about the seat of the original tumor, or in remote parts of the body, the appearance of nodules, which increase in size, and prove to be composed of the same elements as is the original growth, and to possess the same tendency toward the surrounding tissues, and to present the same characters in respect to invasion of the terri-

tory about them, and the same liability to undergo retrogressive changes, and to thus cause ulceration in the regions in which they are situated. These metastases are not always to be found upon the surface of the body, but may take place in the internal organs, or may be found in the brain; in which locations they may cause the signs of softening of the brain, or may cause some of the appearances of mental disease, or may produce paralysis. At times the development of sarcoma is observed in the tongue, or in some of the soft tissues about the floor of the mouth, or in relation with the glands of the part, particularly the parotid gland. These diseases are all of serious nature, and should be early subjected to careful and complete extermination by surgical means; as the smallest portion left behind in an operation for removal of a sarcomatous growth is almost sure to be the means of reproducing the entire disease, and often in an aggravated form. A relapse of a tumor, or a metastasis, in other words, is almost always more serious in its influence upon the system than was the original disease. There is a time in almost all forms of tumors during which they seem to be possessed only of a local character, and during which time they may be fully and completely eradicated by proper local treatment, the object of which should be to remove every particle of diseased tissue and to take out with it a margin of the sound and uninfected flesh on all sides of the tumor. In this way it is often possible to remove all traces of a growth, which, if left undisturbed, or if injudiciously treated, would certainly become dis-

seminated through the system and would bring about the death of the patient. The appearance of a new growth in any part of the body, but especially in the soft structures, is always a suspicious circumstance, and the rapid increase in size of such a growth is indicative of malignancy in its nature. It is desirable to form an opinion of the nature of a pathological growth at as early a period as possible, so that treatment for its removal may be carried out before it has reached a degree of dissemination in the body of the individual, or has invaded parts of such a character, that the surgeon cannot safely follow it for its complete extermination.

When sarcomatous growths are observed in the upper jaw, they are most frequently located in, or are adjacent to the cavity of the antrum of Highmore, and are usually accompanied by bulging of that portion of the alveolar process which is situated over this cavity. Or they may be seated upon the base of the sphenoid bone, or spring from some other point upon the base of the skull, and by their growth may project into and fill out the nasal space, and at length produce the appearances of tumor of the superior maxillary bone.

Such growths are usually possessed of a greater degree of malignancy than are the sarcomata of the lower jaw, owing, in part at least, to the greater vascularity of the tissues of the upper maxilla. The tumor may develop rapidly and fill the entire nasal fossa of one or the other side, and portions may extend into the anterior and posterior openings, so as to entirely occlude the passage. The growth of

the tumor may cause the absorption of the turbinated bones; it may press the nasal septum to the opposite side, and it may occasionally encroach upon the nasal fossa opposite to that in which it was first developed. When any such massive development of the pathological growth has been reached, it is usually found that the palate process of the superior maxillary bone is more or less affected, and at times there is destruction of the bony tissue, and sometimes even a perforation of the roof of the mouth by the malignant growth. When the origin of the tumor is at the base of the skull, there is a greater liability that it will appear on both sides of the nasal septum, and thus encroach upon the functions of both sides of the nose, as well as affect both sides of the maxillary bone in its further development.

Certain connective-tissue growths of the upper jaw are related to the parotid gland, and from this point of origin extend into the neighboring parts of the upper jaw. These growths are always unilateral, are accompanied by swelling in the region of the gland itself, and are often associated with paralysis of the muscles of the side of the face upon which the tumor is located. The occurrence of facial paralysis should always lead to a careful examination of the parotid region; for the facial nerve in a portion of its course passes through a part of the gland, and any indurative affection of this structure, or any increase in its textures, may evidence itself by the suspension of the function of this nerve or of its branches, from pressure upon its trunk in this part of its course. Oftentimes the beginnings of a growth of undoubted malig-

nant character are from small areas of connective tissue in the glands of lymphatic or other character. The primary enlargement of these textures may thus sometimes be productive of indications in the direction of morbid formations, which have the highest importance.

The tumors belonging to the structure of the tooth itself are not numerous, and belong to a comparatively restricted class of pathological growths. Among the true tumors of the teeth are to be reckoned the frequent cases of enlargement of the apical extremity of the tooth, extending to a greater or less distance toward the body or crown of the tooth. These enlargements, though frequently caused by a long-continued and slowly-advancing irritation of the connective-tissue textures of the tooth, are not generally the cause of any apprehension in the direction of malignancy. They are usually observed only when the tooth has been removed, either on account of the pain sometimes accompanying the irritative process above spoken of, or they may, by their size and position, cause the displacement of the tooth, from the lifting of its body by the growth of the tumor at its root. The bony growths at the roots of the teeth are not usually accompanied by any tendency to extend beyond the situation first occupied by them; they do not exhibit a disposition to form metastases, and are therefore in all essential respects of benign character. The periosteum about them may be a trifle thickened in some cases, much as the skin becomes thickened at the location of some old injury, but the condition of both the hard and the

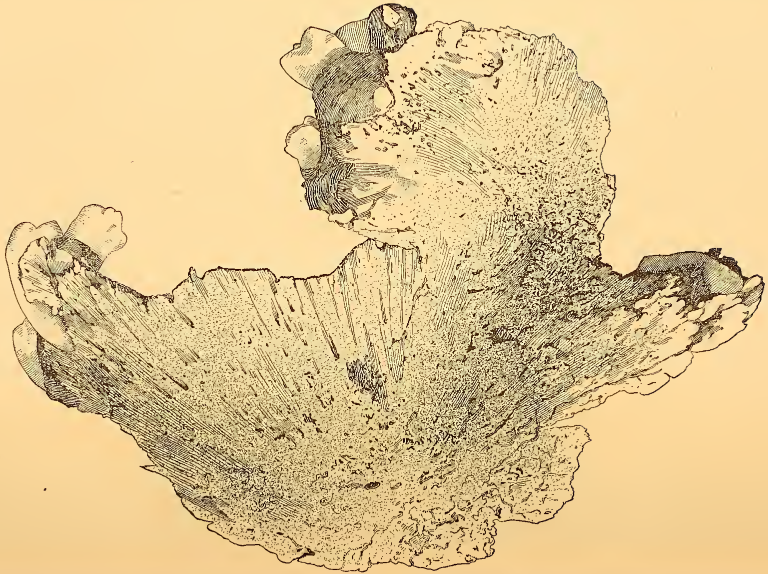
soft tissues about the seat of the enlargement is not usually affected by the proximity of the morbid growth.

Among the pathological growths of true dental nature must be classed those rare developments of pathological character which are composed of true dental tissues, and not of bone. To a certain degree the development of the dental textures into abnormal forms is not an infrequent occurrence, as is noticed in the formation of masses of so-called "secondary dentine," in the teeth of the aged, or in certain teeth which have been much subjected to wear. The development of an accessory portion of the dentine is then to be regarded as a conservative process on the part of the system, for the better preservation of the textures of the teeth, when these have been deteriorated or reduced by excessive use, or by the changes incident to advancing life. The extent to which this process may be carried on in certain cases is truly remarkable, and teeth are at times seen in which a large amount of a useful tooth is made up of the deposit of new dentine, forming a serviceable substitute for the portion of the tooth which has been lost by attrition, or has in some other way suffered gradual destruction. In such teeth the cavity of the interior of the tooth, the pulp canal, is also often intruded upon by the process of secondary formation of dentine, and we see the new material located in the interior of the pulp canal as irregular masses of dentine, or sometimes as small isolated nodules, which are often called "pulp stones." Such teeth are not usually sensitive to pressure; they are often quite

anæsthetic, from the absorption of the sensitive portions of the pulp, so that they appear much like those teeth in which the nervous pulp, the sensitive portion, has been removed by surgical means. This pathological process has a great similarity to a preservative function, and might be called *constructive*, in distinction to *destructive* pathology.

In rare instances we may observe the formation of true tumors composed of the same kind of tissue as that forming the body of the tooth, that is, of true dentine, and presenting all the characteristics of this tissue, and not those of ordinary bone. The development of large masses of dentine is not frequent, and the specimens of this disease are rare in the extreme. For a very interesting account of a tumor of this character, situated at the side of a tooth, and inclosed within the alveolar process, see *London Lancet*, January 14th, 1888, by Mr. Jordan Lloyd, F.R.C.S., which is called in the report a "composite odontome." The growth in this case was observed to possess a radiating structure, with regular composition corresponding in histological arrangement and general character to the ordinary dentine of normal tooth structure. The specimen has been preserved, and is figured in the article above alluded to.

In certain cases there is observed a fusion of parts or the entire mass of neighboring teeth, forming a large and irregular collection of dental tissues, sometimes composed of mingled portions of dentine and enamel, confused with one another, and forming a most perplexing study. These irregular growths are most frequently the result of malformation during the



Plates of bone removed from the wall of a Dermoid Cyst of the left ovary of a patient aged 36. Two unsymmetrical bony plates, like the parietal bones of an infant's head, with a suture between them. The bones were covered with periosteum. The concave margins of the bones were studded with incisors, canine and molar teeth, of perfect form and development, which projected inward toward the centre of the cyst. On the concave surface of the bones were here and there scattered isolated teeth. (Reported in *Boston Medical and Surgical Journal*, March 8th, 1888.) Operation was performed Jan. 14th, 1888. Highest temperature 100.2° F. Highest pulse 90. Patient went home well Feb. 14th, 1888. Diagnosis before operation: "Large unilocular cyst of left ovary." Weight of cyst 1¾ lbs. Weight of contents 10 lbs. The cyst contained a very large amount of vernix caseosa. This patient represented the 407th case of laparotomy and the 305th case of ovariotomy operated by Dr. John Homans, of Boston, to whose courtesy I am indebted for these notes, which he kindly dictated from his records. For the plates I am indebted to the Editor of the *Boston Medical and Surgical Journal*, who generously loaned them for publication.

developmental period of the denture, or fusion of one or more adjacent teeth, and are doubtless associated with the malposition of the tooth germs, or with accident attending their growth. That these are the chief causative elements is indicated, though not proved, by the fact that these malformations are not observed in the primary denture. It would seem that the period of development of the second denture is the time of formation of these curious dental irregularities.

Another curious pathological production of the dental tissues is observed in certain of the formations which are observed in the composition of some of the tumors of the ovaries in women. These tumors are often quite large, and the operation for their removal constitutes one of the forms of laparotomy. In certain of these tumors, called Dermoid Cysts, there are sometimes found portions of fœtal bones of irregular character, hair, sometimes in great abundance, and strangest and most unaccountable of all, there are often found well-developed teeth, or dwarfed or misshapen masses of dental tissues, containing all the histological elements of the normal structure of the human tooth. These tumors are not the result of conception or of impregnation, but are the abnormal product of some diseased process in the body of the patient, which has as its result the formation of portions of the human organism in unusual locations and in strange surroundings.

ENCHONDROMA.

Several varieties of cartilaginous growths are observed in the region of the mouth, but these are not common, and are usually of benign character when they exist, and, moreover, they are usually or at least frequently of congenital origin, so that they are not considered to be of great importance to the well-being of the individual. This class of growth does not tend to make metastases, nor to seriously interfere with the health, and is usually made the subject of operation more for cosmetic reasons than from any other cause. The substance of the tumor is always one of the varieties of cartilage, and the class of growths is for that reason denominated "enchondroma." They sometimes increase in size to a degree to produce deformity of the face, but do not generally degenerate into other forms of tissue, nor produce ulceration or any other serious organic result.

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